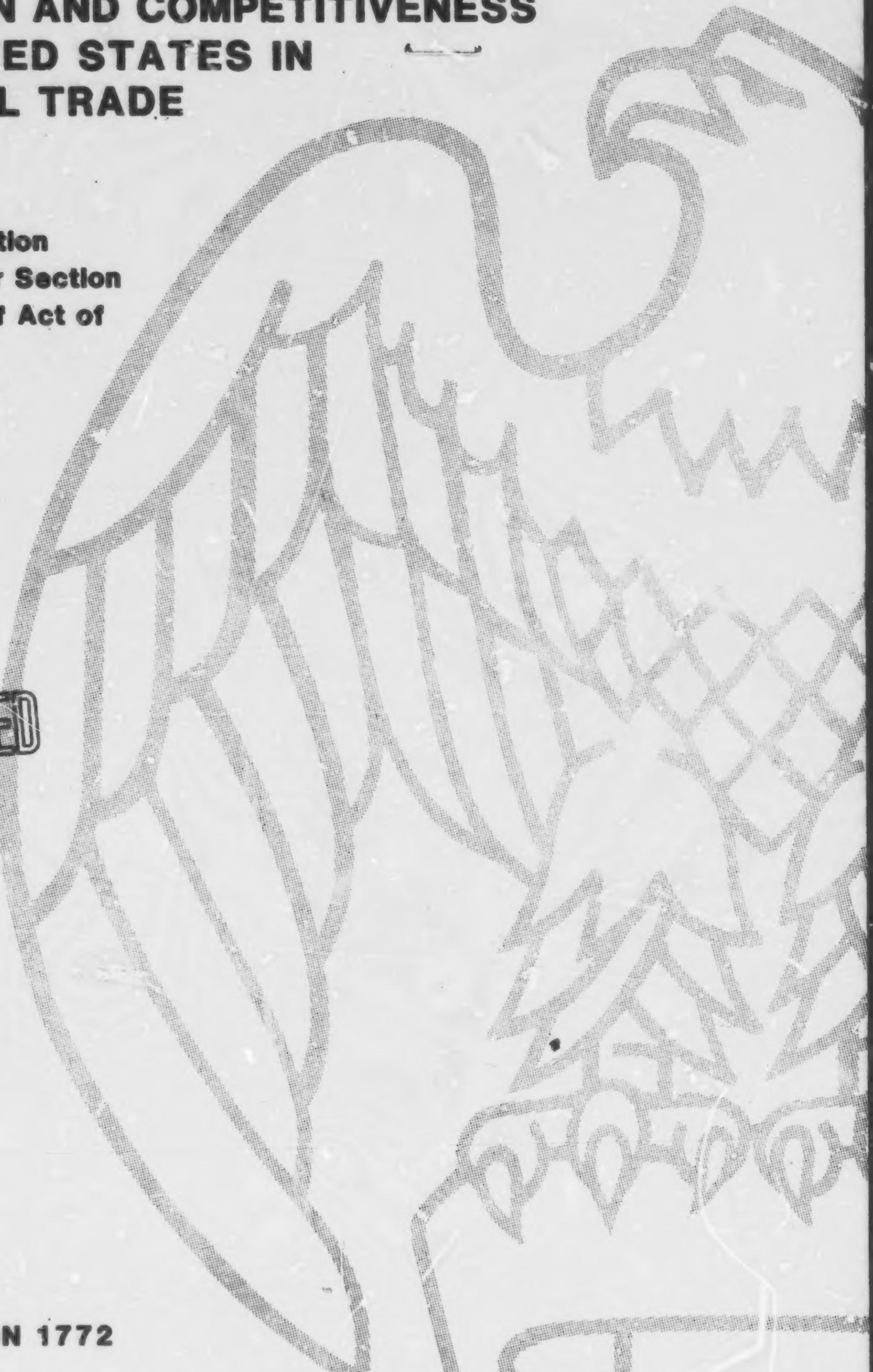
DEC 0 4 1985

ITC 1.12:332-182

THE POSITION AND COMPETITIVENESS OF THE UNITED STATES IN WORLD COAL TRADE

Report on Investigation
No. 332-182 Under Section
332 (b) of the Tariff Act of
1930



ORIGINAL

COMPLETED
138.

USITC PUBLICATION 1772

OCTOBER 1985

United States International Trade Commission / Washington, DC 20436

UNITED STATES INTERNATIONAL TRADE COMMISSION

COMMISSIONERS

Paula Stern, Chairwoman
Susan W. Liebeler, Vice Chairman
Alfred E. Eckes
Seeley G. Lodwick
David B. Rohr

Prepared principally by:

Cynthia B. Foreso, Project Leader

Edward J. Taylor

Stephen Wanser

Elizabeth R. Nesbitt

Erland Heginbotham

Director, Office of Industries

Address all communications to
Kenneth R. Mason, Secretary to the Commission
United States International Trade Commission
Washington, DC 20436

PREFACE

On April 5, 1984, the United States International Trade Commission, in accordance with the provisions of section 332(b) of the Tariff Act of 1930 (19 U.S.C. 1332(b)), instituted investigation No. 332-182 on its own motion for the purpose of assessing the position and competitiveness of the United States in world coal trade. Notice of the investigation was published in the April 18, 1984, issue of the Federal Register (49 F.R. 15285). Information for this report was obtained from Commission fieldwork, industry submissions and publications, the Commission files, other Government agencies, and other sources.

The United States leads the rest of the world's nations in total recoverable coal reserves and has been an important factor in world coal trade. Developments both in the United States and other coal-rich nations could affect the future position and competitiveness of the U.S. coal industry. The United States has the potential of using its reserves to become relatively less dependent on other energy sources, including crude petroleum imports, as well as using the reserves to produce chemical feedstocks.

The report includes analyses of the factors, such as U.S. supply, production, consumption, and trade, that influence the U.S. coal industry, as well as the coal industries of other coal-rich nations. The report estimates the possible implications of changing world crude petroleum prices on U.S. coal trade, output, and employment.

BLANK PAGE

CONTENTS

Page

- Preface — i
- Executive summary — vii

- Introduction:

  - U.S. coal trade — 1
  - Types of coal — 4
  - Disadvantages and advantages of using coal — 7

    - Disadvantages:

      - Consumption — 7
      - Production — 8

    - Advantages:

      - Consumption — 9
      - Production — 9
  - Competition with other energy sources — 10
  - Price equivalency — 12

- United States:

  - Reserves — 13
  - Geographic coal areas — 15
    - Appalachian region — 15
    - Interior region — 16
    - Western region — 17
  - Industry structure — 18
  - Production — 19
  - Productivity — 21
  - Price — 21
  - Consumption — 24
    - Electricity generation — 24

    - Industrial:

      - Coke — 26
      - Industrial and miscellaneous uses — 26
    - Residential/commercial — 27
  - Trade — 27
  - Research and development — 36
    - Coal technology — 41
      - Coal gasification — 41
      - Coal liquefaction — 42
    - Coal-methanol motor fuel — 42
  - Transportation — 43
    - Railroads — 44
    - Ports — 46
    - Barges — 48
    - Trucks — 48
    - Slurry pipelines — 50
- Current and anticipated industry status in other coal-rich nations — 50

  - Australia:

    - Reserves — 52
    - Production — 53

CONTENTS

Page

Current and anticipated industry status in other coal-rich nations--Continued

Australia--Continued

Importance to the economy 54
Consumption 54
Industry structure 55
Trade 56

West Germany:

Reserves 56
Production 57
Importance to the economy 58
Consumption 59
Industry structure 59
Trade 60

United Kingdom:

Reserves 60
Production 61
Importance to the economy 63
Consumption 63
Industry structure 65
Trade 66

The Republic of South Africa:

Reserves 67
Production 68
Importance to the economy 68
Consumption 69
Industry structure 69
Trade 70

U.S.S.R:

Reserves 71
Production 73
Importance to the economy 74
Consumption 74
Industry structure 75
Trade 76

People's Republic of China:

Reserves 77
Production 78
Importance to the economy 79
Consumption 79
Industry structure 80
Trade 81

Poland:

Reserves 83
Production 84
Importance to the economy 84
Consumption 84

CONTENTS

Page

Current and anticipated industry status in other coal-rich nations--Continued
Poland--Continued
Industry structure---------- 85
Trade---------- 86
Colombia:
Reserves---------- 88
Production---------- 89
Importance to the economy---------- 90
Consumption---------- 90
Industry structure---------- 90
Trade---------- 92
Future prospects for world coal demand---------- 93
Electricity generation---------- 93
General industry---------- 95
Residential---------- 95
Development of coal technology---------- 96
Coal cleaning---------- 96
Coal-liquid mixtures---------- 96
Fluidized bed combustion---------- 96
Competing energy sources and environmental concerns---------- 97
Possible implications of changing world crude petroleum prices on U.S. the coal trade---------- 97
Net trade:
Scenarios---------- 98
Low-price scenario---------- 100
High-price scenario---------- 100
Price-shock scenario---------- 100
Comparison of three scenarios and DRI's base case---------- 101
Input-output model---------- 101
Changes in industry output---------- 105
Changes in industry employment---------- 105

Figures

1. Principal U.S. coal basins and rail and waterway routes to coal ports---------- 45
2. U.S. waterway system and principal locks and dams for coal transportation---------- 49
3. Existing and proposed coal slurry pipeline systems---------- 51
4. Comparative crude petroleum price scenarios---------- 99
5. DRI base case forecast of metallurgical and steam-coal exports---------- 102
6. Forecast of U.S. metallurgical coal exports under the three-price scenarios---------- 103
7. Forecast of U.S. steam coal exports under the three scenarios---------- 104

CONTENTS

Page

Tables

1. World steam coal trade, 1973-84 2
2. World coal trade, 1990 and 1995 5
3. Comparative imported steam coal prices, mid-1981 6
4. Percentage distribution of electricity generation, by energy sources in the United States, 1972-83 11
5. Price comparisons in current and constant currency, of coal and specified fossil fuels, 1973-83 14
6. Coal: U.S. production, 1980-84 20
7. Coal: U.S. production, by type, 1980-84 22
8. Labor productivity in coal mining, by specified years, 1950-83 23
9. U.S. consumption, by end-use sectors, 1950-84 25
10. Coal and other carbonaceous material: U.S. imports for consumption, by principal sources, 1980-84 28
11. Bituminous and lignite coal: U.S. imports for consumption, by principal sources, 1980-84 29
12. Anthracite coal: U.S. imports for consumption, by principal sources, 1980-84 30
13. Coke: U.S. imports for consumption, by principal sources, 1980-84 31
14. Other coal and carbonaceous materials: U.S. imports for consumption, by principal sources, 1980-84 32
15. Coal and other carbonaceous material: U.S. exports of domestic merchandise, by principal markets, 1980-84 34
16. Bituminous and lignite coal: U.S. exports of domestic merchandise, by principal markets, 1980-84 35
17. Anthracite coal: U.S. exports of domestic merchandise, by principal markets, 1980-84 37
18. Coke: U.S. exports of domestic merchandise, by principal markets, 1980-84 38
19. Other coal and carbonaceous materials: U.S. exports of domestic merchandise, by principal markets, 1980-84 39
20. Steam-coal import projections, 1985-2000 94
21. U.S. coal trade balance, under the low-, high-, and shock-price scenarios, 1990, and 1995 100
22. Possible increases in output as a result of net trade increases between 1983 and the scenarios in 1990 and 1995, by specified sectors 106
23. Possible gains in the number of jobs as a result of the net trade increases between 1983 and the scenarios in 1990 and 1995, by specified sectors 107

EXECUTIVE SUMMARY

The United States leads the rest of the world's nations in total recoverable coal reserves, providing it with an important competitive edge in world coal trade. Historically, the United States has been either the leading or one of the leading world exporters of coal. The United States has been viewed as a secure supply source in a market faced with labor problems and production disruptions.

Competition for world coal markets is expected to be intense as South Africa, Australia, and other coal-rich nations produce coal for export to European and Pacific Rim markets. South Africa has been the primary supplier of the Western Europe market while Australia supplied the Pacific Rim markets. However, the United States is in a more favorable position in terms of reserves, production, and supply security. Also, the U.S. coal industry has shown the ability to respond quickly to changing market conditions. As a result, it is likely that the United States could remain the world's major coal supplier in 1990 and 1995.

Coal is a naturally occurring, combustible, organic, solid material formed from decayed plant remains, metamorphosed over time to produce the different ranks (the degree of metamorphism) of coal. The ranks of coal are as follows:

(1) Anthracite (2 percent of total reserves),
(2) Bituminous (51 percent),
(3) Sub-bituminous (39 percent), and
(4) Lignite (9 percent)

Bituminous coal is further classified into two commodity classes, steam coal (which is used as a fossil fuel) and metallurgical coal (which is used for the manufacture of coke, which is in turn used in the production of steel).

The following highlights are the major findings of the Commission's investigation:

1. Competitive Factors of the U.S. Coal Industry in the World Coal Market.

   o The United States is the world's leader in terms of recoverable reserves and production of coal.

The United States, with 1.7 trillion short tons of coal reserves, has the world's largest coal resource base and has been the world's largest coal producer in recent years. U.S. coal production increased from 830 million short tons in 1980 to a record high of 890 million short tons in 1984.

The primary use for coal is as a fossil fuel; however another important use for coal is the production of coke and coal chemical byproducts such as crude coal tar, coke over gas, light oil, and ammonia. The leading U.S. consumers of coal are electric utilities.

- World steam coal trade reached a record high in 1981 of 298.8 million metric tons of which the United States accounted for 38 percent of the total coal supplied to the world market.

The United States imported 1.9 million short tons of coal and exported 94.3 million short tons in 1984. In 1980, U.S. coal exports benefitted from labor unrest in Australia, Poland, and South Africa as the United States became a swing supplier of coal to the world market. In 1981, the United States accounted for 38 percent of the total world coal exports, however, U.S. exports declined in 1982 and 1983. As importing nations' inventories of coal dwindled in 1984, U.S. exports of coal rose to fill an increased demand.

The current capacity of U.S. coal ports is reportedly sufficient to handle future U.S. coal exports; however, in contrast to other coal exporting and importing countries with ports to accommodate large, deep-draft colliers, U.S. channel depths restrict the United States to the use of vessels of 60,000 deadweight tons or less. In comparison, ports in Australia, South Africa, and Poland can handle ships ranging from 100,000 to 250,000 deadweight tons.

- Coal has been a more economical energy source than either crude petroleum or natural gas for coal's major end-use market, electric utilities.

A comparison of the price of coal in both current and constant (1972=100) currency during the period 1973-83 with that of crude petroleum and natural gas revealed that coal was a more cost-effective energy source on the basis of price per British thermal unit (Btu) than either of its two fossil fuel rivals, crude petroleum and natural gas. Coal also competes for certain energy markets with other energy sources that are either decades away from commercialization (i.e., fusion energy), are currently being utilized to the maximum (i.e., hydropower), or are of limited potential for large-scale use (i.e., geothermal energy). Coal does not compete across the board for all energy markets. For example, it is unlikely that coal will compete with petroleum, natural gas, or electricity for the home/residential market, or with petroleum or electricity in the railroad industry.

2. Competitive Factors of Other Coal-Rich Nations in the World Coal Market.

- Other coal-rich nations operate under similar circumstances as the United States, however, each country has certain differences that may influence the degree of coal industry development success in the future.

Australia

Australia, with 48.6 billion metric tons of coal reserves, exports nearly 50 percent of its total coal production and has large segments of its coal industry dependent on the export market. As a result, new coal projects are dependent upon increased world demand for Australian coal. Most of Australia's coal exports are metallurgical coals to Japan; however, the labor unrest in Australia in the early 1980's resulted in Japan's turning toward the United States as a more secure source of coal.

West Germany

West Germany, with about 285 billion metric tons of coal reserves, accounts for about 77 percent of total European Community (EC) coal exports. The major markets for these exports are other EC members. The West German coal industry has been strengthened by a series of economic programs designed to improve mining conditions and to increase domestic coal consumption. The latter, although causing exports to decrease, has led to the relaxation of import quotas in effect since 1959. West Germany, in the fore-front of coal conversion technology, developed many of the major processes still used today.

United Kingdom

The United Kingdom has about 45 billion metric tons of coal reserves, it exports coal primarily to other EC members. The National Coal Board (NCB), which is responsible for the development of the coal industry in the United Kingdom, is one of the largest producers of coal in the Western World, and it has one of the largest programs for coal research. The NCB has implemented the "Plan for Coal" to increase production, research and development, and exploration. Financial problems, mainly incurred through rising costs in the investment programs, however, may affect future undertakings. Import restrictions were instituted in 1981 to avoid mine closures and a reduction of capacity. Coal exports are expected to increase as the United Kingdom attempts to expand penetration of its markets.

Republic of South Africa

The Republic of South Africa (South Africa), with coal reserves of about 58 billion metric tons, produced about 140 million metric tons of coal in 1982. About 40 percent of the total production was consumed domestically, and 25 percent was exported in 1983. Most coal exports are steam coal bound for the EC; Japan is another major coal market. Although the Government is responsible for coal exploration and development, foreign investment is allowed.

Union of Soviet Socialist Republics

The Union of Soviet Socialist Republics (U.S.S.R.), a nonmarket economy that does not permit foreign investment in its coal industry, reportedly contains about 24 percent of the world's known coal reserves. Siberia accounts for 90 percent of the U.S.S.R.'s coal reserves, with about 75 percent of these reserves located in the Asian portion of Siberia, far removed from the industrial plants in the European portion of the U.S.S.R. Weather conditions (temperatures of minus 40 to minus 50 degrees Fahrenheit) in this coal-rich region are severe, often hampering coal recovery, by causing frequent equipment failure, including frozen conveyor belts.

Coal production in 1981 amounted to 704 million metric tons and supplied about 37 percent of the U.S.S.R.'s electricity needs. The U.S.S.R.'s coal imports come mainly from Poland and are negligible (2 percent or less of annual consumption). Coal exports from the U.S.S.R. are reported at less than 5 percent of annual coal production and are projected to remain at that level because of growing internal needs. Most coal exports from the U.S.S.R. go to Council for Mutual Economic Assistance (COMECON) 1/ countries primarily through bartering agreements.

People's Republic of China

The People's Republic of China (China) is a nonmarket economy that not only permits foreign investment in its coal industry, but also actively encourages it. China ranks third in the world, behind the United States and the U.S.S.R., in terms of coal reserves. China's coal reserves are located principally in the northern part of the country in Shanxi province and Inner Mongolia, although deposits are widely scattered throughout the country. Coal production in the major mines comes under the authority of the Ministry of Coal Industry. A large number of smaller coal mines are controlled by local governments, a still larger number mines are run by the communes.

China's coal production reached a record high of nearly 644 million metric tons in 1982; imports consisted of small amounts of coking coal. China expected to export 18 million to 20 million metric tons of coal a year by 1985. The major reasons for the low level of China's coal exports are increased domestic demand from the expanding industrial sector and a reportedly over burdened infrastructure, which is currently being upgraded and modernized.

Poland

Poland, also a nonmarket economy that encourages joint ventures with Western firms in its coal industry, reportedly has an estimated 120 billion

---

1/ COMECON, was established during 1949-51. The original members were the U.S.S.R., Bulgaria, Czechoslovakia, Hungary, Poland, and Romania. Albania was a temporary member; other current full members are East Germany, Mongolian People's Republic, Cuba, and Vietnam. Yugoslavia is an associate member, and North Korea takes part in certain COMECON activities. The People's Republic of Yemen, Angola, Laos, and Afghanistan attend certain COMECON meetings as observers.

tons of coal reserves. Poland, the fourth largest producer of coal, produced a record high of 201 million metric tons in 1979. Coal production in Poland declined in 1980 and 1981 from that in 1979 because of labor unrest; however, the Polish Government succeeded in increasing coal output in 1982 and 1983.

Coal supplies about 80 percent of Poland's industrial energy needs and 95 percent of Poland's electricity; imports of coal are negligible. Poland has been second only to the United States in terms of the quantity of coal exported in recent years (with the exception of 1980 and 1981). Polish coal exports to the West provide hard currency used to repay the nation's debt and purchase needed Western goods.

Colombia

Colombia, accounting for 40 percent of Latin America's total coal reserves, is expected to produce 2.7 million metric tons of coal from El Cerrejon in 1985. The El Cerrejon project is jointly owned by Carbocol (the state-owned coal company) and a large U.S.-based multinational petroleum company. Currently, each party controls 50 percent of the coal produced and is responsible for marketing its own coal; however, in 2009, the contract expires and all the coal reverts to Carbocol. Colombia does not import coal, relying completely on domestic production to satisfy demand. Until early 1985, Colombia's coal exports were negligible; however, all the coal produced from the El Cerrejon project is slated for export primarily to Western Europe. The United States and Israel also are current markets for Colombian coal exports. Although Colombia is currently not a major world exporter of coal, it is expected that they will become a major factor in the world coal market as the El Cerrejon project fully comes on-stream.

3. Possible Future Position of the United States in World Coal Trade.

The United States, with its large resource base and one of the world's most sophisticated transportation infrastructures, could increase its positive trade balance in coal by 1995.

For this study, future U.S. coal trade was forecasted on the basis of the price of crude petroleum. Three independent future crude petroleum price scenarios--low, high, and price shock--were used as input into the Coal Service of Data Resources, Inc. to measure the effects of these crude petroleum price scenarios on U.S. coal trade. The following tabulation shows these scenarios (per barrel): 1/

1/ In 1983 dollars.

BEST COPY AVAILABLE

Year	Low crude petroleum price scenario	High crude petroleum price scenario	Crude petroleum price shock scenario
1990	$26	$41	$90
1995	37	70	75

Under each scenario, the United States maintains a positive trade balance in terms of coal; however, the positive trade balance is the highest when the price of crude petroleum is at its lowest level, as shown in the following tabulation (in millions of nominal dollars): [1]

Year	Low-price scenario	High-price scenario	Price shock scenario
1990	5,382.0	5,110.0	4,834.8
1995	7,912.9	7,632.2	7,475.5

- Under all three crude petroleum price scenarios, U.S. exports of steam coal could increase, whereas metallurgical coal exports could steadily increase only if petroleum prices are low.

Under the three crude petroleum price scenarios, U.S. metallurgical coal exports increase only under the low-price scenario to about 55 million short tons in 1995 if future crude petroleum prices remain low. Metallurgical coal exports could increase under the low price scenario assuming that an improved economy resulted in increased steel production and thus increased coke production. U.S. steam coal exports could increase to 29 million short tons over the same period regardless if crude petroleum prices are low (assuming that the low prices resulted in decreased exploration and supply of crude petroleum) or high (if importing nations view coal as a more attractive energy source).

- Increases in the coal trade balance could result in the U.S. economy showing industry-output increases of $2.9 billion by 1990 and $8.3 billion by 1995 and employment gains of up to 83,302 jobs by 1990 and 241,736 jobs by 1995.

---

[1] Trade balances are shown in nominal dollars in order to compare data without consideration of the effects of inflation during the period. Data derived from the Coal Service of Data Resources, Inc.

Net trade increases between the scenarios were calculated in order to determine changes in industry output and employment using the U.S. Department of Labor's input/output model. The model can be used to calculate the change in U.S. industry output and employment resulting from any given hypothetical change in final demand for a domestically produced commodity.

The coal-mining sector could show increases in output of $888 million to $1.5 billion and a gain of 26,145 to 44,406 jobs in 1990; an increase of $3.9 billion to $4.4 billion in industry output and from 114,266 to 128,862 jobs could be experienced in 1995, depending on the price of crude petroleum. The U.S. economy could witness output increases of $1.7 billion to $2.9 billion by 1990 and $7.4 billion to $8.3 billion by 1995. The entire U.S. economy could gain from 49,047 to 83,302 jobs in 1990 and from 214,355 to 214,736 jobs in 1995. The following tabulation shows the possible range of gains in output and employment for certain other key sectors of the economy in 1990 and 1995, on the basis of the price of crude petroleum:

Sector	1990		1995	
	Output	Employment	Output	Employment
	Million nominal dollars		Million nominal dollars	
Crude petroleum/natural gas	16-27	251-426	68-77	1,096-1,236
Mining equipment	60-101	1,598-2,715	260-294	6,985-7,878
Transportation:				
Railroads	10-17	313-532	45-50	1,370-1,545
Trucks	16-27	666-1,132	68-77	2,911-3,282
Water	2-4	63-107	10-12	274-309
Services	1/-1	71-120	3-4	308-348
Electric utilities	31-53	462-785	137-155	2,020-2,278

1/ Less than $1 million.

INTRODUCTION

U.S. Coal Trade

The United States and several other nations began exporting coal in the late 1800's for use as bunker fuel and as fuel for steam engines. Until World War I, the United States exported coal primarily to Canada, the West Indies, and Central America. During World War I, U.S. coal exports to Western Europe began and rose rapidly due to the wartime disruption of European coal production. After the war, the United States and the United Kingdom competed for the European coal market. However, by the 1930's, world coal trade decreased as a result of a worldwide depression and reduced demand for coal particularly by industry, the primary user. In addition, crude petroleum surpassed coal as the primary bunker fuel during this period.

By the early 1960's, coal was unable to compete with low-priced crude petroleum in most fuel markets. As a result, U.S. coal exports were almost entirely comprised of metallurgical coals. However, in 1974 and 1979, the price of crude petroleum rose significantly and once again, nations looked toward coal as an alternate fuel source.

In 1980, U.S. coal trade also benefitted from labor unrest in Australia, Poland, and South Africa, and such unrest led to decreased exports from these nations. The United States became a swing supplier of coal. As shown in table 1, world coal trade reached a record high in 1981 when 298.8 million metric tons of coal were traded. The United States, the world's major supplier, accounted for 38 percent of the total. U.S. coal exports declined in 1982 because of a reduction in demand by European and Pacific Rim nations as well as the resumption of coal exports by Poland. 1/ The rise in value of the U.S. dollar vis-a-vis other currencies also had an adverse effect on U.S. coal exports.

In 1983, world coal demand continued to decline as European and Pacific Rim nations relied on their coal inventories to satisfy demand. These large inventories had been stockpiled during 1980-82 in response to supply disruptions incurred as a result of labor disputes in the major coal-exporting nations. Also, the price of crude petroleum fell to $29 per barrel, and world demand for steel and electricity remained depressed. World demand for coal showed a slight upturn in 1984 primarily as a result of the importing nations' dwindling inventories. Although crude petroleum prices remained low, world steam coal demand increased slightly in response to the current unstable petroleum price situation.

1/ Stanislaw Zajac, op. cit; "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11; and, "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, eastern edition, Aug. 8, 1983, pp. 1 and 12.

Table 1.--World coal trade, 1973-84

(Millions of metric tons)

Year	Exporters									
	United States	Australia	Poland	South Africa	U.S.S.R.	Canada	West Germany	China 1/	Other 2/	Total
1973	53.6	31.0	39.5	2.1	27.0	12.1	15.3	0.3	10.0	190.9
1974	60.7	32.5	44.1	2.5	28.9	11.9	19.2	0.4	9.7	209.9
1975	66.3	33.5	42.4	3.0	28.8	12.9	16.2	0.5	8.7	215.5
1976	60.0	34.3	42.9	6.6	29.6	13.0	14.4	0.4	8.9	210.2
1977	54.3	42.3	43.3	14.0	31.1	13.3	16.0	0.5	9.7	224.7
1978	40.7	42.6	44.2	17.0	31.6	15.1	21.0	0.9	9.4	222.5
1979	66.0	44.6	45.6	25.7	28.4	15.3	17.2	1.7	10.4	254.9
1980	91.7	47.2	34.5	31.4	28.2	15.8	14.0	6.8	14.1	283.6
1981	112.5	54.8	16.5	33.0	24.3	17.7	13.6	3/	26.5	298.8
1982	106.3	54.9	31.2	30.3	23.9	17.6	10.6	3/	21.4	296.2
1983	70.4	59.6	35.2	27.1	21.5	17.1	3/	3/	28.6	259.5
1984 4/	73.5	63.9	39.5	28.9	21.8	19.8	3/	3/	24.7	272.1

	Importers					
	Western Europe	Japan	Eastern Europe	Canada 5/	Other 2/	Total
1973	67.0	62.7	36.3	16.5	8.5	190.9
1974	79.3	70.7	35.6	13.6	10.7	209.9
1975	80.8	68.5	35.1	16.8	11.3	212.5
1976	80.2	67.0	35.4	16.1	11.6	210.2
1977	85.9	67.1	36.8	16.9	18.1	224.7
1978	94.3	57.5	38.4	14.6	18.1	222.5
1979	107.4	64.5	40.2	19.4	23.4	254.9
1980	123.0	75.6	33.6	17.5	33.9	283.6
1981	126.8	86.4	33.7	18.2	33.7	298.8
1982	121.7	86.3	33.2	18.6	36.4	296.2
1983	98.8	74.7	33.8	13.7	24.8	259.5
1984 4/	100.1	77.2	35.6	13.3	45.9	272.1

See footnotes at end of table.

Table 1.--World coal trade, 1973-84--Continued

(Percent)

Year	United States	Australia	Poland	South Africa	U.S.S.R.	Canada	West Germany	China 1/	Other 2/	Total
	Exporters									
1973	28	16	21	1	14	6	8	0.1	5	100
1974	29	15	21	1	14	6	9	.2	5	100
1975	31	16	20	1	13	6	8	.2	4	100
1976	29	16	20	3	14	6	7	.2	4	100
1977	24	19	19	6	14	6	7	.2	4	100
1978	18	19	20	8	14	7	9	.4	4	100
1979	26	17	18	10	11	6	7	.6	4	100
1980	32	17	12	11	10	6	5	2	5	100
1981	38	18	6	11	8	6	5	3/	9	100
1982	36	19	11	10	8	6	4	3/	7	100
1983	27	23	14	10	8	7	3/	3/	11	100
1984 4/	27	23	15	11	8	7	3/	3/	9	100

Year	Western Europe	Japan	Eastern Europe	Canada 5/	Other 2/	Total
	Importers					
1973	35	33	19	9	4	100
1974	38	34	17	6	5	100
1975	38	32	17	8	5	100
1976	38	32	17	8	6	100
1977	38	30	16	8	8	100
1978	42	26	17	7	8	100
1979	42	25	16	8	9	100
1980	43	27	12	6	12	100
1981	42	29	11	6	11	100
1982	41	29	11	6	12	100
1983	38	28	13	5	10	100
1984 4/	37	28	13	5	17	100

1/ Exports during 1973-75 are to Japan only.
2/ Estimated.
3/ Not available.
4/ Estimated.
5/ Imports during 1981-84 are from the United States only.

Source: U.S. Department of Energy, Annual Prospects for World Coal Trade, 1984, With Projections to 1995, July 1984, p. 2 and The Chase Manhattan Bank, The Coal Situation, various issues.

Note.--Because of rounding, figures may not add to totals shown.

Competition for future European and Pacific Rim coal markets is expected to be intense, as South Africa, Australia, and other coal-rich nations are increasing production primarily for export. The United States, Australia, South Africa, and Poland are likely to remain the major world coal suppliers in 1990 and 1995 (table 2). The United States could remain the principal world supplier of metallurgical coal, with Western Europe being the major market, if the steel industries in these industrial nations recover from the economic recession and expand. U.S. steam-coal exports are also expected to capture the largest share of the future world coal market despite higher U.S. prices (see table 3).

Australia has been a low-cost supplier to the Pacific Rim, and South Africa has been the primary supplier of the Western Europe market. However, compared with these nations, the United States is in a favorable position in terms of reserves, production, quality of coal, and supply security. The U.S. coal industry has shown the ability to respond quickly to changing market conditions, and the Western Europe market has viewed the U.S. free-pricing system for coal as advantageous in holding prices down. 1/

The major world markets for coal are Japan and Western Europe. The major sources of coal to these markets are the United States, Australia, and South Africa. World demand for coal is influenced by the price of crude petroleum. When crude petroleum prices are high, consumers tend to switch to alternative energy sources. Demand for coke is influenced by the level of steel production.

Types of Coal

Coal is a naturally occurring, combustible, organic solid material formed from decayed plant remains, metamorphosed over time to produce the different ranks of coal. Coal is composed primarily of carbon and hydrogen, with small amounts of other substances. An important feature of coal is its heating value, which is generally measured in British thermal units (Btu's) per pound or kilocalories per kilogram. 2/

Coal is classified by type (the differences in plant materials from which the coal was originated); grade (the percentage of noncombustible impurities in the coal); and, most importantly, by rank (the degree of metamorphism). The ranks of coal are as follows:

(1) Anthracite - a hard, jet black coal with a high luster, used for generating electricity and space heating;

(2) Bituminous - the most common coal, also known as soft coal, is dense and black, often with well-defined bands of bright and dull material visible, used for generating electricity, making coke, and for space heating;

1/ Ibid., pp. 18-19.

2/ One Btu is the heat amount needed to raise the temperature of 1 pound of water one degree Fahrenheit. One kilocalorie equals 3.9685 Btu's.

Table 2.--World coal trade, 1990 and 1995

(In millions of short tons)

Exporters	Steam coal import markets					
	Western Europe		Pacific Rim		Total 1/	
	1990	1995	1990	1995	1990	1995
United States	36	39	4	10	49	58
Australia	14	19	20	25	33	44
Poland	14	26	0	0	32	46
South Africa	20	37	23	15	44	54
All other 2/	27	20	19	42	58	76
Total	111	143	64	92	216	278
	Metallurgical coal import markets					
	Western Europe		Pacific Rim		Total 1/	
	1990	1995	1990	1995	1990	1995
United States	24	31	18	14	55	58
Australia	5	5	44	48	51	55
Poland	11	12	-	-	14	17
South Africa	-	-	3	2	3	4
All other 2/	12	13	22	28	50	58
Total	52	61	87	92	173	192

1/ Includes other importing regions, such as South America, Eastern Canada, and Eastern Europe.

2/ Includes other exporting regions, such as Canada, China, Colombia, West Germany, the United Kingdom, and the U.S.S.R.

Source: U.S. Department of Energy, Annual Prospects for World Coal Trade 1984, July 1984, p. 28.

Table 3.--Comparative imported steam-coal prices, mid-1981 1/

(Per short ton)

Exporter	F.o.b. port		Ocean freight		Delivered price	
	Western Europe	Japan	Western Europe	Japan	Western Europe	Japan
United States 2/	$50	$50	$18	$28	$68	$78
Poland	54	3/	8	3/	62	3/
South Africa	43	43	13	22	56	65
Australia	44	44	26	16	70	60

1/ Import prices are shown for mid-1981 because these prices were in effect prior to labor unrest, which resulted in rapidly fluctuating prices.

2/ East coast.

3/ Poland does not export coal to Japan.

Source: U.S. Government Accounting Office, Prospects for Long-Term U.S. Coal Exports to European and Pacific Rim Markets, Aug. 4, 1983, p. 17.

(3) Sub-bituminous - a dull black coal, used for generating electricity and space heating; and

(4) Lignite - a brownish-black coal with a high moisture content, used for generating electricity.

Bituminous coal is further classified into two commodity classes, steam coal and metallurgical coal, corresponding roughly to its two major end-use markets. Steam coal is used as a fossil fuel, and metallurgical coal is used for the manufacture of coke, used in the production of steel.

Disadvantages and Advantages of Using Coal

It is necessary to consider many factors when comparing the attractiveness of various energy supplies. The costs of extracting, transporting, transforming, storing, and using the fuels must be compared. 1/ Therefore, it is necessary to consider factors other than production costs when comparing the disadvantages and advantages of coal with those of petroleum, natural gas, and so forth.

Disadvantages

Consumption

As a solid material, coal is the least convenient fossil fuel. Coal is dirty and difficult to dig, transport, and use. 2/ It is also more expensive to store, handle, and burn than petroleum or natural gas. Since coal is a solid and also has a lower Btu per volume than either petroleum or natural gas, more storage space is required, which can be a difficult problem in developed industrial areas. 3/ Therefore, efforts to develop a coal slurry or to gasify coal are attempts to make it as much like petroleum and natural gas as possible.

As an energy source, coal generally presents more of a pollution problem than either natural gas or petroleum. 4/ The major environmental problems

---

1/ Richard L. Gordon, Coal in the U.S. Energy Market; History and Prospects, Lexington, MA, 1978, pp. 61 and 62.

2/ Robert Noyes, Coal Resources, Characteristics and Ownership in the U.S.A., Park Ridge, NJ, 1978; and, Charles Combs, Coal in the Energy Crisis, New York, NY, 1980, pp. 12 and 13.

3/ Coal Industry Advisory Board, International Energy Agency, OECD, The Use of Coal in Industry, May 1983, p. 43.

4/ "How Acid Rain Might Dampen the Utilities," Fortune, Aug. 8, 1983, pp. 58-64; "Cleaning to Zero Seldom Pays," Coal Age, January 1983, pp. 50-55; Congressional Office of Technology Assessment, The Direct Use of Coal: Prospects and Problems of Production and Combustion, Ballinger Energy Series, 1981, pp. 7-9 and 183-255; and Carroll L. Wilson, Coal-Bridge to the Future, Cambridge, MA, 1980, pp. 26-33.

associated with coal include land reclamation after surface mining, acid mine drainage or sediment problems after mine abandonment, safe disposal of ashes, air pollution, and "acid deposition," more commonly known as "acid rain." Acid rain is a condition which results from the emission of certain chemicals, sulfur dioxides and sulfates and nitrous oxides, into the atmosphere. These gases combine with water vapor in clouds to form sulfuric and nitric acid. When precipitation falls from the clouds, it is highly acidic and is harmful to fish and other aquatic life. Acid rain also damages trees, especially conifers such as fir, pine, and spruce as well as certain deciduous trees, such as beech. Coal-fired and oil-fired electric generating plants along with automobile emissions are the major sources of acid rain. 1/

Concern about air quality in the United States led to the Clean Air Act of 1963, which mandated an overall strategy for reducing air pollution. Major amendments to this act followed in 1970 and 1977 to enhance air pollution controls. In 1984, for the fourth year in a row, Congress did not reauthorize the Clean Air Act of 1963 which is administered by the Environmental Protection Agency. However, the continuing appropriations for FY 1985 continued funding for several acid rain research programs as well as provided federal support for clean coal technology products. 2/

The conversion to coal-fired systems has been hindered by the high capital investments required to convert petroleum- and/or natural-gas operated boilers to the use of coal, which can prove to be very costly. For example, the investment required to replace boilers in all Organization for Economic Cooperation and Development (OECD) countries, without Government incentives would amount to an estimated $13 billion by 1990; however, this would result in an annual estimated savings of $11 billion, which would rise if the price gap between petroleum and coal widens in the 1990's. 3/ For the United States alone, the cumulative investment costs would rise by $4 billion if all petroleum and natural gas boilers were discontinued by January 1, 1985, and replaced with new coal-fired capacity. 4/

Production

Since coal production is more labor intensive than petroleum or natural gas production, strikes or threats of strikes have hindered coal's public

---

1/ "European Concern About Acid Rain Is Growing," Chemical & Engineering News, Jan. 28, 1985, pp. 12-18; "Acid Rain Policy: White House Cool on Envoy Proposal," Chemical & Engineering News, Sept. 23, 1985, p. 4; and Subcommittee on Fossil and Synthetic Fuels of the Committee on Energy and Commerce, House of Representatives, Future of Coal, Dec. 2, 1983, Mar. 22, 1984, and Aug. 31, 1984, pp. 12-24.

2/ U.S. Department of Energy, Annual Outlook for U.S. Coal 1985: With Projections to 1995, May 1985, pp. 5, 10, and 29.

3/ Robert Noyes, op. cit.; and, International Energy Agency, OECD, The Use of Coal in Industry, May 1982, pp. 11-13.

4/ Ibid.

acceptance. 1/ Location is another deterrent to coal's more rapid acceptance as a viable alternative to petroleum and natural gas. 2/ For example, much of the preferred low-sulfur coal is found in the Rocky Mountain region, which can make transportation costs to industrial areas or seaports prohibitive.

Advantages

Consumption

Coal does have advantages in certain areas over its fossil fuel rivals, petroleum and natural gas. For the United States, first and foremost among these advantages is coal's availability. The United States has estimated recoverable coal reserves sufficient for about 300 years at current production rates. 3/ Also, gasification and liquification techniques, which make coal more transportable, could allow it to be competitive with petroleum and natural gas in the generation of power and the production of petrochemicals. 4/

Although coal requires complex and expensive pollution control equipment, such as scrubbers which are designed for coal-fired boilers, some industry sources believe that fuel savings generated with coal purchases, compared with petroleum or natural gas, would compensate for the investment in stack gas scrubbers in less than 2 years, provided utilities were allowed to charge the same price per Btu for coal as for petroleum or natural gas. 5/

Production

The principal advantage to using coal is that U.S. production is based on a large reserve base, which is not being depleted as rapidly as its fossil fuel competitors, petroleum, and natural gas. Therefore, coal's price to the utility companies should not rise as rapidly as either of the other two fossil

---

1/ "Where is the Industry Going? Towards a Weak Recovery," Coal Mining and Processing, January 1984, pp. 26-30.

2/ Richard L. Gordon, op. cit., pp. 61, 171, and 172; "King Coal's Black Eyes," Fortune, Oct. 31, 1983, p. 58; and, "For Coal The Recovery is Heating Up Slowly," Business Week; Aug. 1, 1983, pp. 89 and 90.

3/ Peter James, The Future of Coal, London, 1982, p. 99; The Direct Use of Coal: Prospects and Problems of Production and Combustion, op. cit.; and, Annual Energy Review 1983 April 1984, pp. 182 and 183.

4/ The Coal Committee of the Economic Commission of the United Nations for Europe headed by Dr. Zygmunt Wegrzyk, "The Future Role of Coal," Geneva, Switzerland, summer 1983.

5/ Office of Technology Assessment, Industrial Energy Use, June 1983, pp. 50 and 51; "OPEC Makes Old King Coal Less Merry," The Economist, Mar. 27, 1982, pp. 88 and 89; and, "Coal Faces Near Term Troubles Despite Price Advantage," Oil & Gas Journal, Dec. 20, 1982, pp. 17-20.

fuel sources. 1/ One source predicts that by late 1987-early 1988, delivered petroleum prices will be $8 to $9 per million Btu's compared with $2.50 to $3 per million Btu's for coal. 2/

Competition With Other Energy Sources

Coal competes for energy markets primarily with petroleum and natural gas, and, to a lesser extent, with nuclear power (table 4). Other energy sources, such as fusion energy, solar radiation, geothermal energy, hydraulic power, and tidal energy, are either decades away from being commercially available (i.e., fusion energy), are being utilized to the maximum now, or are of limited potential for large-scale industrial/utility use owing to economics (i.e., solar radiation) or intrinsic limitations (i.e., geothermal energy).

Coal does not compete across the board for energy markets. For example, coal as a solid material is unlikely to compete with petroleum, natural gas, or electricity for the home/residential market. 3/ Coal is delivered by truck, storage in the house is messy, the furnace requires daily stoking, it is necessary to dispose of ash, and residential coal burning leaves smoke and fumes in the air. Transportation is not a likely market for coal unless the coal is first converted to a more convenient form. Currently, it is not economically feasible to convert coal to a suitable form when petroleum is available at one-third to one-half the cost of synthetic fuels produced from coal.

Coal competes with other energy sources primarily in the heat and steam-generating markets and is expected to do so for at least the next two decades. 4/ As mentioned previously, the two major areas of competition for coal are in electric generating plants and in energy-intensive industries such as steel, chemicals, aluminum, and cement.

Coal's competitiveness is determined by its price per unit of obtainable heat after adjusting for handling, utilization, and other characteristics unique to coal. On an equivalent heating basis, coal is substantially less expensive than petroleum. 5/ However, coal's competitive price advantage is

---

1/ Petroleum, in spite of its projected price rise, is forecast to account for 63 percent of the total petroleum and natural gas consumed by electric utilities in 1990 compared with 41 percent in 1980. This was drawn from the U.S. Department of Energy's, 1983 Annual Outlook for U.S. Coal, November 1983, pp. 14 and 15.

2/ "Coal Faces Near Term Troubles Despite Price Advantage," Oil & Gas Journal, Dec. 20, 1983, p. 20.

3/ Office of Technology Assessment, The Direct Use of Coal: Prospects and Problems of Production and Combustion, Ballinger Energy Series, 1981, pp. 33, 40, 45, and 46.

4/ Carrol L. Wilson, Coal-Bridge to the Future: Report of the World Coal Study, Cambridge, MA, 1980, p. 25.

5/ "Japanese See More Stable Worldwide Coal Prices in Future," Coal Age, February 1983, p. 21; Carroll L. Wilson, op. cit., pp. 25-26; and Richard Hellman and Caroline J.C. Hellman, op. cit., p. 80.

Table 4.--Percentage distribution of electricity generation by energy sources in the United States, 1972-83

Year	Coal	Crude petroleum	Gas	Nuclear energy	Hydro energy
1972	44.1	15.7	21.5	3.1	15.6
1973	45.6	16.9	18.3	4.5	14.6
1974	44.4	16.1	17.1	6.1	16.1
1975	44.5	15.1	15.6	9.0	15.6
1976	46.3	15.7	14.5	11.8	10.4
1977	46.4	16.9	14.4	11.8	10.4
1978	44.2	16.5	13.8	12.5	12.7
1979	47.8	13.5	14.7	11.4	12.4
1980	50.8	10.8	15.1	11.0	12.1
1981	52.4	9.0	15.1	11.9	11.4
1982	53.2	6.5	13.6	12.6	13.8
1983	54.6	6.3	11.9	12.6	14.4

Source: Official statistics of the U.S. Department of Energy.

reduced by the high capital costs associated with burning coal (e.g., pollution control equipment). 1/ Coal's competitive price advantage is further constrained by the facilities and infrastructure now in place as a result of previous energy decisions, usually favoring petroleum and natural gas. However, a long-term increase in the prices of petroleum and natural gas could be a strong incentive for conversion, since coal is abundantly available in the United States and could be used to replace foreign crude petroleum if the national interest so requires. 2/

Price Equivalency

Table 5 compares the price 3/ of coal with that of other fossil fuels in both current and constant (1972=100) currency. In current prices, crude petroleum increased at an average annual rate of more than 21 percent during 1973-83 compared with nearly 28 percent for natural gas, 13.2 percent for bituminous coal and lignite, 14.3 percent for anthracite, and more than 21 percent for the fossil fuel composite. In terms of constant (1972=100) prices, these average annual rates of growth for these energy sources during this period were 12.6, 19.1, 5.4, 6.4, and 12.9 percent, respectively.

During 1973-83, coal was a more cost-effective energy source than either of its two fossil fuel rivals. Crude petroleum prices declined by about 18 percent during 1981-83, but bituminous coal and lignite coal prices increased by more than 7 percent, and anthracite, by more than 19 percent. In other words, the price trend of coal does not necessarily reflect that of crude petroleum, especially when coal enjoys such an overall advantage on a price per Btu basis.

As shown in the following tabulation, in recent years coal has been a more economical energy source than either petroleum or natural gas, its two traditional fossil fuel competitors for its two major end-use markets, the industrial sector and electric utilities (average energy prices in dollars per million Btu's). 4/

1/ Ibid.

2/ "Coal Faces Near Term Troubles Despite Price Advantages," Oil & Gas Journal, Dec. 20, 1982, pp. 17-20; and, "DRI Pessimistic in Short-Term," Coal Outlook, Mar. 14, 1983, pp. 4 and 5; and Robert Noyes, op. cit.

3/ All fuel prices taken as close as possible to the point of production.

4/ U.S. Department of Energy, Annual Energy Review 1983, April 1984, p. 41. Data are not yet available for more recent years.

Year	Industrial			Electric utilities		
	Petroleum	Natural gas	Coal	Petroleum	Natural gas	Coal
1973	$1.11	$0.45	$0.46	$0.81	$0.34	$0.46
1974	2.18	.63	.87	1.90	.48	1.19
1975	2.36	.86	1.14	2.01	.75	1.05
1976	2.46	1.09	1.08	1.97	1.03	.92
1977	2.74	1.32	1.17	2.23	1.29	1.08
1978	2.83	1.50	1.37	2.16	1.42	1.29
1979	3.84	2.18	1.29	3.05	1.74	1.26
1980	5.39	2.36	1.34	4.35	2.19	1.39
1981	7.00	2.92	1.52	5.43	2.80	1.53

Electricity prices are determined by the utilities' cost of producing and delivering electric power to consumers. Even though coal is a solid fuel and more difficult to transport and store than either crude petroleum or natural gas, coal still affords a price savings as an energy source compared with its two leading rivals.

UNITED STATES

Reserves 1/

The United States has the world's largest coal resource base. Total entified coal resources are estimated at 1.7 trillion short tons, of which

---

1/ According to the U.S. Department of Energy, "total resource," the amount of coal that existed before any production. It consists of the total volume formed and trapped in place within the earth. A portion of this total resource is not recoverable by current or foreseeable technology for two principal reasons. First, much of it is dispersed in very low concentrations throughout the earth's crust and cannot be extracted without mining the rock or applying some other approach that could consume more energy than it covered. Second, an additional portion of the total resource volume cannot be recovered because available production of technology cannot extract all of the coal. This technical inability to recover 100 percent of the in-place deposit may result from the economics involved, intractable physical forces, or a combination of both. The concept of "recoverable resources" normally excludes these unrecoverable fractions.

The "total recoverable resource" includes both discovered and undiscovered recoverable resources. "Discovered recoverable resources" consist of two major parts: cumulative production and reserves. "Cumulative production is the sum of the current year's production and the production that occurred in all prior years." "Reserves" are the volume estimated to exist in known deposits and believed to be recoverable in the future through the application of present or anticipated technology.

Table 5.--Price comparisons in current and constant currency, of coal and specified fossil fuels, 1973-83

(In cents per million Btu's)

Item	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Crude petroleum:											
Current	67.1	118.4	132.2	141.2	147.8	155.2	217.9	372.2	547.8	491.7	449.5
Constant	63.5	102.9	105.1	106.7	105.5	103.2	133.3	208.6	280.7	237.7	208.4
Natural gas:											
Current	20.1	27.3	41.1	53.1	72.3	83.6	108.1	144.8	179.5	222.2	234.9
Constant	19.0	23.7	32.7	40.1	51.6	55.6	66.1	81.2	92.0	107.4	108.9
Bituminous coal and lignite:											
Current	36.7	68.8	84.3	85.0	88.2	98.3	105.7	109.7	118.2	122.3	127.2
Constant	34.7	59.6	67.0	64.2	63.0	65.4	64.7	61.5	60.6	59.1	59.0
Anthracite:											
Current	58.9	98.4	137.9	149.0	150.4	149.9	174.1	182.1	186.9	210.4	223.2
Constant	55.7	85.5	109.6	112.6	107.4	99.7	106.5	102.1	95.8	101.7	103.5
Composite:											
Current	39.9	67.7	82.6	90.2	100.9	111.7	141.8	204.3	274.7	275.9	273.4
Constant	37.7	58.8	65.7	68.2	72.0	74.3	86.8	114.5	140.8	133.4	126.8

Source: U.S. Department of Energy.

473 billion short tons are classified as the Demonstrated Reserve Base (DRB). 1/ The DRB represents the amount of coal contained in coal beds that meet certain criteria of geological assurance, depth, and seam thickness. About two-thirds of the DRB consists of underground reserves. About 50 percent of the underground reserves and 80 percent of the surface reserves are considered recoverable. Natural features, such as folded or interlayered rock strata in both underground and surface mines, reduce the amount of coal that can be recovered. Also, some coal must remain in underground mines in the form of pillars to support the mine roof. Some coal deposits are under towns and cities and cannot be mined. The recoverable portion of the DRB is estimated to be at least 236 billion short tons, sufficient for about 300 years at current annual production rates. 2/ Currently, coal reserves are distributed over large areas of the United States, as shown in the following tabulation: 3/

Coal rank	Eastern United States 1/	Western United States 2/	Total	Percent of total
	Billion short tons			
Anthracite	7	-	7	2
Bituminous	203	36	239	51
Sub-bituminous	0	182	182	39
Lignite	1	43	44	9
Total	212	261	473	100

1/ States east of the Mississippi River.
2/ States west of the Mississippi River.

Geographic Coal Areas

All the major ranks and subranks of coal are found in the United States and are distributed over a wide geographic area. Because of the large distances that can separate coal deposits from the ultimate user, transportation costs become an important factor in defining regional markets. The lower the rank and the higher the moisture and ash content, the higher the delivered cost per Btu.

Appalachian Region

The Appalachian region, which consists of Alabama, eastern Kentucky, Maryland, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia, extends some 800 miles along the Appalachian mountains from northern

---

1/ U.S. Department of Energy, 1983 Annual Outlook for U.S. Coal, November 1983, p. 8.
2/ Ibid.
3/ Ibid.

Pennsylvania to central Alabama. The Appalachian region is both commercially and geologically the oldest coal region in the United States. It is also historically the largest coal producing region. In 1983, the Appalachian region accounted for 52 percent of total U.S. production, though it constitutes only about 25 percent of total U.S. reserves. Because of its geologic age, Appalachian coal has been subjected to the greatest heat and pressure. As a result, the coal is predominantly bituminous and has a low ash and moisture content. Sulfur content ranges usually from 1 to 3 percent. This region has the only significant reserves of anthracite coal which are located in northern Pennsylvania. Central Appalachia has the largest deposits of eastern low-sulfur premium coal. Premium coal is defined as having less than one percent sulfur and 5 percent ash. The deposits of low- and medium-volatile premium coal are concentrated in southern West Virginia and some southwestern counties of Virginia. This area accounts for 78 percent of U.S. medium- volatile, premium-grade coking coal and 99 percent of U.S. low-volatile, premium coking coal. 1/ Historically, this coal has been sold to the steel industry, both domestic and foreign. However, with the pending acid rain legislation, Appalachian low-sulfur coal is being considered for use as steam coal. 2/ The Appalachian terrain is generally mountainous, and a variety of mining methods are required to access the coal. Because this area has been mined extensively, industry analysts believe the future costs of mining in this region will rise faster than in either the Interior or Western regions. 3/

The Appalachian region has an extensive railroad infrastructure that can move coal either to the domestic consumer or to major ports on the east coast or the Great Lakes for export. Parts of central Appalachia have access to the Ohio River Basin, allowing river access to the Gulf of Mexico. Canada and Western Europe currently are the largest markets for Appalachian exports.

Interior Region

The States located in the Interior Region include Arkansas, Illinois, Indiana, Iowa, Kansas, western Kentucky, Missouri, Oklahoma, and Texas. In 1983, this region accounted for 21 percent of U.S. coal production. This region contains two major basins: the Illinois and the Western Interior. The Illinois is by far the more important; in 1983, this basin produced 74 percent of the total Interior Region's coal production. Although the Western Interior has deposits spread over a large geographic area, the coal seams are generally thin. Furthermore, many of the deposits in Arkansas and all the deposits in Texas are lower rank lignite.

Coal from the Illinois Basin is bituminous and is found in seams up to 14 feet thick. The typography of this region is largely flat or gently rolling, with large coal deposits located close to the surface (outcrops).

1/ Illinois Coal Association, Illinois Coal Facts, 1984, p. 25.

2/ Congressional Research Service, Acid Rain Legislation and the Future of the Eastern Low-Sulfur Coal Industry, April 1984.

3/ Ibid.

About one-half of the coal mined in the region comes from surface mines. The underground mines are relatively deep, up to 900 feet. The combination of deep underground mines and extensive strip mining makes mining in this area capital intensive. As a result, large mining companies predominate in this region. Coal from the Illinois Basin is sold to steel companies, electric utilities, and industry, with much of the coal sold to the steel industry coming from captive mines. A problem with Illinois coal is the high sulfur content (3 to 5 percent). The steel industry has been able to blend this coal with coal from other regions in order to minimize sulfur content. In some instances, the coking ovens have been substantially modified to contend with the sulfur. The product market most adversely affected by the high sulfur content is steam coal. As a result of the 1970 Federal Clean Air Act and its subsequent amendments, electric utilities have been forced to lower their sulfur emissions. They have to a large extent achieved the emission standards by purchasing Western low-sulfur coal. In 1983, Illinois public utilities alone purchased approximately 18 million tons of Western low-sulfur coal. 1/ The alternative to Western coal is to use technological sulfur control devices (e.g., scrubbers).

Western Region

The States included in the Western Region are Alaska, Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming. Western coal was first mined in the early 1860's and became a major energy source as the West developed. After World War II, Western coal decreased in importance as the nation switched from coal to petroleum and natural gas. The combined political and economic issues of the 1970's renewed interest in coal, and Western coal was the primary beneficiary of the renewed interest. After the Middle East crude petroleum disruptions focused attention on coal as an important alternative to crude petroleum in achieving energy independence, it was Western coal that had the largest reserves of easily accessible coal. When concern for the environment forced the utilities to reduce sulfur emissions (and as concern over the environmental hazards associated with nuclear intensified), burning low-sulfur Western coal was the most cost-effective solution. This solution became more effective with the introduction of the "unit train." 2/

The following tabulation shows the increased coal production in selected western States that occurred between 1970 and 1980 (in millions of tons): 3/

1/ Illinois Coal Association, Illinois Coal Facts, 1984, p. 25.

2/ See "Transportation" section for explanation of unit trains.

3/ Western Coal Export Task Force, Western Coal Exports to the Pacific Rim, 1981, Vol. 13, p. 16.

State	1970	1975	1980
Colorado	6.03	8.22	18.7
Montana	3.45	22.05	29.8
New Mexico	7.36	8.99	18.9
Wyoming	7.20	23.80	92.0
All other	5.47	18.24	29.6
Total	29.51	81.30	189.0

The Western Region has large reserves of bituminous coal (24.7 billion short tons) and virtually all the reserves of sub-bituminous coal (181.7 billion short tons). 1/ Major basins of bituminous coal exist in Utah, Colorado, Wyoming, and northern Montana. The seams are relatively deep and require underground mining. Much of this bituminous coal is suitable for coking. The major sub-bituminous basins are found in Wyoming, Colorado, and New Mexico. This coal is strip mined and used exclusively as "steam coal."

The Western coal industry can be summarized as having large reserves, of a variety of ranks, much of which is low sulfur. The mines are relatively new and less subject to depletion. They are typically large, capital intensive, and exhibit increasing economies of scale; consequently, productivity is high. The coal is sold to utilities, industry, coking plants, and the export market.

Industry Structure

The three largest coal-producing States are Kentucky (with 25 percent of the total U.S. coal mined), West Virginia (21 percent), and Wyoming (18 percent). The combined production of the seven largest coal-producing States accounted for 72 percent of total U.S. production. 2/

There are approximately 4,098 mines in the United States that produce 10,000 or more short tons of coal per year. There are perhaps another 1,500 smaller mines, most of which are located in Appalachia. Of the total mines, 2,107 were surface mines and 1,991 were underground mines. The largest number, 3,592 (1,862 underground and 1,730 surface), were located in the Appalachian region; another 371 (70 underground and 301 surface) were located in the Interior region; and the remaining 134 (58 underground, 76 surface) were located in the Western region. 3/

In 1983, 60 percent of the coal mined was by strip mining and 40 percent by underground mining. Of the total coal mined, 74.2 percent was bituminous coal; 19 percent, subbituminous coal; 6.3 percent, lignite; and 0.5 percent,

---

1/ U.S. Department of Energy, Coal Production-1983, app. 4, September 1983.
2/ U.S. Department of Energy, Coal Production, 1982, September 1983, p. 1.
3/ Ibid.

anthracite. 1/ The Appalachian region produced 427.9 million short tons (51.4 percent of the total), the Interior region produced 177.9 million short tons (21.4 percent), and the Western region produced 226.7 million short tons (27.2 percent).

The U.S. coal industry is composed of landowners, mining companies, equipment suppliers, and transportation companies. The large, integrated coal companies dominate the market. There are approximately 15 coal organizations, that controlled about 42 percent of total U.S. coal output in 1982. 2/

The crude petroleum/natural gas companies' share of total coal production increased from about 2 percent in the early 1960's to 23 percent by the 1970's and 1980's. 3/ In 1963, the first major U.S. petroleum company purchased a large, privately owned coal company. By 1969, four large, independent coal producers were purchased by companies in the petroleum industry. By 1983, it was reported that 36 U.S. petroleum companies owned 72.7 billion tons of coal reserves and that in 1982, these companies produced 30 percent (255.8 million tons) of total U.S. coal production. 4/

Participation in the coal industry by other industries also includes foreign multinationals. In 1980, 27 million tons (slightly greater than 3 percent) of coal were produced by foreign-owned mines. This compares with 13 percent of petroleum and natural gas products produced by foreign-controlled companies. 5/

Production

U.S. production of coal (excluding coke) decreased from 830 million short tons in 1980 to 825 million short tons in 1981 as a result of labor strikes (table 6). U.S. production increased to 838 million short tons in 1982 as a result of record export demand. U.S. coal production decreased to 782 million short tons in 1983 because consumers depleted large inventories which had been stockpiled earlier in anticipation of petroleum storages and higher coal prices. Production in 1984 surpassed the 1982 levels reaching 890 million short tons, valued at $25 billion.

Bituminous coal (steam coal) is highly demanded for its use as an energy source. As shown in table 7, U.S. production of bituminous and lignite coals, which accounts for 90-95 percent of U.S. production, increased from 824 million short tons, valued at $21 billion, in 1980 to 828 million short tons, valued at $22.5 billion, in 1982 and to 886 million short tons, valued at $22

1/ Ibid.

2/ U.S. Department of Energy, Quarterly Coal Report, January-March 1983, July 1983, p. xii.

3/ Schmidt, Richard A., Coal in America, McGraw-Hill Publications Co., 1979, p. 146.

4/ "Markets and Related News," Keystone News-Bulletin 41, 11 (November 25, 1983), pp. 2-3.

5/ U.S. Department of Commerce, Technical Paper on the U.S. Coal Industry for U.S.-Japan Energy Working Groups, July 1983, p. 219.

Table 6.--Coal: 1/ U.S. production, 1980-84

Year	Quantity	Value	Unit value
	1,000 short tons	1,000 dollars	Per short ton
1980	829,700	20,452,105	24.65
1981	823,775	21,747,660	26.40
1982	838,112	22,838,552	27.25
1983	782,091	22,486,382	28.62
1984	890,143	24,968,511	$28.05

1/ Includes bituminous, lignite, and anthracite coal, and other carbonaceous materials, except coke.

Source: Compiled from official statistics of the U.S. Department of Energy.

billion, in 1984. U.S. production of anthracite coal decreased from 6.1 million short tons in 1980 to 4 million short tons in 1984. However, the value of anthracite coal increased from $42.51 per short ton in 1980 to an estimated $51.24 per short ton in 1984. U.S. production of coke decreased from 46 million short tons, valued at $4.9 billion, in 1980 to 30 million short tons, valued at $3 billion, in 1984 (table 7).

Productivity

Labor productivity in U.S. coal mining increased by 195 percent, from 6.75 short tons per miner day in 1950 to 19.90 short tons per miner day in 1969 (table 8). This increase in productivity resulted from increased use of surface mining, and new capital-intensive underground mining techniques, which began to result in significant productivity increases in 1981 in conjunction with increased export demand. Today, mining technology is relatively mature. Most improvements are the result of larger and more reliable equipment. New scrubber-equipped, continuous-mining machines that are operated by remote control are now being used successfully in the Illinois Basin. This allows the miners to stay under a supported roof while the machine makes advances into the coal seam.

Price

Historically, coal prices have reflected fluctuations in demand. During 1950-69, as consumers substituted petroleum and natural gas for coal, prices declined as the industry's excess demand lowered the market clearing price. Beginning in 1970, coal prices increased in terms of both current and constant dollars. This trend reflects in part the added cost associated with environmental and mine safety regulations, as well as the inflationary effects of the period. During 1982-84, coal prices declined as inventories accumulated. This historical price is reflected in the following tabulation derived from official statistics of the U.S. Department of Energy (in dollars per short ton):

Year	F.o.b. mine	C.i.f. electric utility	Coking coal at blast furnace
1950	$4.50	NA	$16.29
1955	4.84	$6.07	12.96
1960	4.69	6.26	18.02
1965	4.44	5.71	16.11
1970	6.26	7.13	27.43
1975	19.23	17.63	84.03
1982	27.14	34.90	113.91
1983	28.00	35.50	114.10
1984	27.48	35.11	105.15

Table 7.--Coal: U.S. production, by type, 1980-84

Year	Bituminous	Anthracite	Coke
	Quantity (1,000 short tons)		
1980	823,600	6,100	46,132
1981	818,400	5,400	42,786
1982	833,500	4,600	28,115
1983	778,000	4,100	25,808
1984	886,100	4,000	30,561
	Value (1,000 dollars)		
1980	20,935,912	259,311	4,919,517
1981	21,515,736	239,112	4,840,808
1982	22,621,190	229,310	3,230,132
1983	20,111,300	214,389	2,938,757
1984	22,442,380	204,960	3,196,069
	Unit value		
1980	$24.52	$42.51	$106.64
1981	26.29	44.28	113.14
1982	27.14	49.85	114.89
1983	25.85	52.29	113.87
1984	25.33	51.24	104.58

Source: Compiled from official statistics of the U.S. Department of Energy.

Table 8.--Labor productivity in coal mining, by specified years, 1950-83

(Average short tons per miner day)

Year	Underground	Surface	Average
1950	5.75	15.66	6.75
1955	9.28	21.17	9.84
1960	10.64	23.31	12.83
1965	14.00	32.76	17.52
1969	15.61	36.00	19.90
1970	13.76	36.26	18.84
1975	9.54	26.69	14.74
1980	9.86	28.22	16.32
1981	20.25	29.50	16.98
1982	1/ 11.16	30.60	18.13
1983	13.18	33.60	21.19

1/ Productivity declined primarily as a result of labor unrest.

Source: U.S. Department of Energy, Coal Data: A Reference, October 1982, pp. 37; U.S. Department of Energy, Coal Production - 1982, September 1983, pp. 57-59.

Note.--Data refer only to bituminous, sub-bituminous, and lignite miners.

Metallurgical coal has consistently been priced higher than steam coal. This reflects the more stringent technical coal requirements and the higher mining costs. Even coal sold to the same industry exhibited considerable price variation, and the average numbers listed in various publications can be misleading. The two primary physical characteristics that determine price are Btu and sulfur content. For example, western sub-bituminous coal and Midwestern bituminous coal have different energy contents, and these differences are reflected in their respective prices. The appropriate measure in this case would be price per Btu. Sulfur content has always been a determinant in the price of metallurgical coal, and since the late 1960's it has been an important factor in the price of steam coal. Usually the price increases as the sulfur content decreases. Other determinants of coal price are ash content, volatility, grindability, and moisture. These latter factors are important price determinants because of the strict operating tolerances under which utility boilers and ancillary equipment operate.

Consumption

The primary use of coal is as a fossil fuel, but another important use is for the production of coke and coal byproducts such as crude coal tar, coke oven gas, light oil, and ammonia. About 92 percent of the coke produced in the United States is used in blast furnaces in the production of steel. About 93 percent of coal tar produced is further refined into tar acid oil, pitch, and other products, with the remainder used as fuel. Tar acid oil is distilled to produce various chemical derivatives, and pitch is used for waterproofing, roofing, and paving.

Electricity Generation

In the United States, coal use for electricity generation rose from 67 percent of total coal consumption in 1972 to 85 percent in 1983 (table 9). This important market for coal did not grow as rapidly as forecasted in the early 1970's, because the demand for electricity grew at a much lower rate (about 3 percent per year during 1973-80) than originally projected. [1] The decline in demand was attributed, in part, to escalating electricity costs that brought about conservation measures. For example, the cost of electricity increased from a weighted-average price of 4.73 cents per kilowatthour in 1980 to 6.29 cents in 1983. Finally, the economic downturn of 1981-82 resulted in a decrease in electricity demand by the industrial sector (i.e., defined by official sources as businesses that generally require more than 1,000 kilowatts of service), the leading U.S. consumer of electricity. The industrial sector annually accounted for between 36 percent and 39 percent of the total demand for electricity in recent years.

---

[1] Electricity demand grew at an average annual rate of 7.3 percent during the 1960's and 4.2 percent during the 1970's. Official sources project total utility electricity sales to climb at an average annual rate of 3.9 percent from 1983-85 and 3.4 percent from 1985-1990.

Table 9.--U.S. consumption, by end-use sectors, 1950-84

(In millions of short tons)

Year	Electric utilities	Coke plants	Industrial and miscellaneous	Transportation	Residential and commercial	Total
1950----	91.9	104.0	120.6	63.0	114.6	494.1
1955----	143.8	107.7	110.1	17.0	68.4	447.0
1960----	176.6	81.4	96.0	3.0	40.9	398.0
1965----	224.8	95.3	105.6	.7	25.7	472.0
1970----	320.2	96.5	90.2	.3	16.1	523.2
1972----	351.8	87.7	72.9	.2	11.7	524.3
1973----	389.2	94.1	68.0	.1	11.1	562.6
1974----	391.8	90.2	64.9	.1	11.4	558.4
1975----	406.0	83.6	63.6	1/	9.4	562.6
1976----	448.4	84.7	61.8	1/	8.9	603.8
1977----	447.1	77.7	61.5	1/	9.0	625.3
1978----	481.2	71.4	63.1	1/	9.5	625.2
1979----	527.1	77.4	67.7	1/	8.4	680.5
1980----	569.3	66.7	60.3	1/	6.5	702.7
1981----	596.8	61.0	67.4	1/	7.4	732.6
1982----	593.7	40.9	64.1	1/	8.2	706.9
1983----	625.2	37.0	66.0	1/	8.4	736.7
1984----	664.4	44.0	73.8	1/	9.1	791.3

1/ Less than 0.05 million short tons.

Source: Data for 1950-81, compiled from U.S. Department of Energy, Coal Data: A Reference, October 1982, p. 50; data for 1982 and 1983, compiled from U.S. Department of Energy, Quarterly Coal Report, October-December 1983, April 1984, p. 26.

Note.--Because of rounding, figures may not add to the totals shown.

Industrial

Coke

Coke is a hard, porous substance made from bituminous coal used primarily in the production of steel. Small quantities are used as fuel or chemical feedstocks. In the United States, nearly all coke is produced in "byproduct recovery" or "slot-ovens." 1/ The major byproduct is a gas that can be sold or used to heat the ovens. Other byproducts include ammonia, tar, and various organic chemicals. Coke producers are either privately owned ("merchant plants") or owned by steel companies ("furnace plants"). Since the 1950's, the majority of these plants have been owned by steel companies in order to maintain a reliable source of coke. In 1982, there were 55 coke plants in operation. Thirty-nine were affiliated with steel companies, and most of these were located at the steel mill.

Selected grades of bituminous coal have been found most suitable for conversion to coke. These grades include all low- and medium-volatile bituminous and most high-volatile bituminous. In addition to these volatility requirements, the coal must have low levels of impurities, such as sulfur and ash. Acceptable levels of these impurities for the U.S. coke industry are 1-percent sulfur and 8-percent ash.

Table 9 shows that coke-oven plants accounted for about 5 percent of domestic consumption of coal in 1983 compared with 5.8 percent in 1982. This use has declined steadily, both in terms of quantity and as a share of total domestic coal consumption, since 1973. For example, in both 1978 and 1979, coke operations represented 11.4 percent of total domestic coal consumption.

Industrial and miscellaneous use

Industrial consumption of coal (exclusive of coke-oven use) accounted for about 9 percent of the total domestic consumption of coal in 1983 (table 9) and was projected to have been more than 11 percent of the total domestic demand for coal in 1984. 2/ Most of coal's remaining industrial use is for steam generation, and small amounts are used for heating in foundaries. For some energy uses, such as in large boilers, coal, crude petroleum, and natural gas are easily interchangeable in a technical, but not necessarily economical, sense. Many existing industrial and utility boilers have the capacity to burn two, and often all three fossil fuels. 3/ For a large proportion of fossil

---

1/ Slot ovens refer to as many as 100 ovens grouped together, each holding 30 to 33 tons of coal, producing 20 to 22 tons of coke. Slot ovens also collect volatile byproducts created by the high temperatures.

2/ Marc D. Cohen, op. cit., p. 7. The U.S. Department of Energy, Annual Energy Review 1983, April 1984, p. 169 "shows other industry and miscellaneous," exclusive of coke plants, at about 9 percent of total domestic coal demand in 1983.

3/ Chase Manhattan Bank, N.A., The Energy Outlook Through 2000, New York, NY, March 1983, p. 6.

fuel use, the energy system selected is only fuel dependent up to and including the boiler. 1/ Thereafter, the distribution of steam and hot water is common to petroleum, natural gas, coal, or any other heat source.

Residential/Commercial

In 1950, coal supplied 36 percent of U.S. energy in the residential/commercial sector, 2/ but declined to 0.7 percent by 1983. 3/ Coal has been replaced in this sector mainly by natural gas, crude petroleum, and electricity because these energy sources are cleaner, more convenient to use, and do not raise the same environmental concerns as coal. Coal demand in the residential/commercial sector is forecasted to decline from 8.5 million short tons of coal per year in 1983 to about 7 million short tons per year during 1985-90.

Trade

U.S. imports of coal and other carbonaceous materials (including coke) decreased from 1.9 million short tons, valued at $83 million, in 1980 to 1.3 million short tons, valued at $45 million, in 1983 (table 10). U.S. imports increased to 1.9 million short tons, valued at $93 million, in 1984.

The Republic of South Africa was the principal source of U.S. coal imports during the period, accounting for an average of 46 percent of total U.S. coal imports. The coal imported from the Republic of South Africa was bituminous and lignite coals and was generally lower priced than other import sources during the period. Total U.S. imports of bituminous and lignite coals increased from 925,000 short tons, valued at $22 million, in 1980 to 1 million short tons, valued at $35 million, in 1984 (table 11).

Anthracite coal imports remained minimal during the period, decreasing in terms of quantity, from 6,000 short tons in 1980 to 5,000 short tons in 1984 (table 12). Because of decreased demand by the U.S. steel industry, U.S. imports of coke decreased from 659,000 short tons, valued at $51 million, in 1980 to 582,000 short tons, valued at $47 million, in 1984 (table 13). The average unit value of U.S. coke imports increased from $78.00 per short ton in 1980 to $80.98 per short ton in 1983. Canada was the principal source of U.S. coke imports during the period.

The United States imports small amounts of other carbonaceous materials primarily from Canada (table 14). These materials include silt, culm, refuse dam, slurry dam, and dredge, which are coals recovered from previously mined coals or refuse mines.

1/ International Energy Agency, OECD, The Use of Coal in Industry, report by the Coal Industry Advisory Board, May 1982, p. 41.

2/ Robert Noyes, Coal Resources, Characteristics and Ownership in the U.S.A., Park Ridge, NJ, 1978.

3/ U.S. Department of Energy, The Annual Energy Review 1983, op. cit., pp. 11, 169, and 250. The Annual Energy Outlook 1983, op. cit., p. 282 defines the commercial sector as nonmanufacturing business establishments including motels, restaurants, laundries, and so forth.

Table 10.--Coal and other carbonaceous material: U.S. imports for consumption, by principal sources, 1980-84

Source	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Japan	352	141	39	1/	354
Rep Saf	770	814	576	744	612
Canada	190	318	196	244	327
Colomb	0	0	0	241	269
France	0	1/	1/	1/	75
Italy	0	0	1/	0	54
Poland	316	31	0	0	109
Argent	146	210	49	12	37
All other	112	75	23	84	29
Total	1,885	1,589	884	1,325	1,868
	Value (1,000 dollars)				
Japan	31,647	13,047	3,362	1	29,690
Rep Saf	16,948	19,877	15,568	21,455	19,645
Canada	11,496	20,023	9,321	11,226	14,548
Colomb	-	-	-	9,131	10,472
France	-	3	1	10	6,637
Italy	-	-	1	-	5,351
Poland	9,542	1,439	-	-	3,732
Argent	6,826	13,870	3,226	323	1,510
All other	6,437	4,079	1,349	3,047	1,033
Total	82,896	72,337	32,829	45,194	92,617
	Unit value (per short ton)				
Japan	$89.86	$92.74	$86.19	$720.00	$83.79
Rep Saf	22.02	24.41	27.01	28.84	32.08
Canada	60.42	62.90	47.56	45.94	44.49
Colomb	-	-	-	37.96	38.91
France	-	322.25	42.32	26.02	87.95
Italy	-	-	29.17	-	98.28
Poland	30.20	46.30	-	-	34.14
Argent	46.88	66.14	65.60	26.99	40.82
All other	57.64	54.05	57.69	36.32	35.44
Average	43.97	45.51	37.13	34.10	49.57

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 11.--Bituminous and lignite coal: U.S. imports for consumption, by principal sources, 1980-84

Source	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Rep Saf	770	814	565	744	559
Colomb	0	0	0	241	243
Canada	5	61	76	133	195
Austral	67	34	23	23	28
Poland	83	3	0	0	6
China M	0	0	0	1/	1/
Indnsia	0	0	0	0	1/
Japan	0	0	0	0	1/
All other	1/	1	1/	60	1/
Total	925	913	663	1,201	1,030
	Value (1,000 dollars)				
Rep Saf	16,946	19,877	14,899	21,455	17,859
Colomb	-	-	-	9,131	9,412
Canada	217	2,907	3,059	4,706	6,732
Austral	2,079	670	945	1,016	880
Poland	2,665	144	-	-	190
China M	-	-	-	1	1
Indnsia	-	-	-	-	1/
Japan	-	-	1/	1/	1/
All other	12	18	1	1,872	1/
Total	21,919	23,615	18,904	38,182	35,074
	Unit value (per short ton)				
Rep Saf	$22.02	$24.41	$26.38	$28.84	$31.97
Colomb	-	-	-	37.96	38.76
Canada	45.11	47.62	40.50	35.33	34.56
Austral	31.12	19.79	41.96	44.41	31.17
Poland	32.08	46.30	-	-	32.71
China M	-	-	-	400.00	500.00
Indnsia	-	-	-	-	376.00
Japan	-	-	-	-	342.00
All other	37.34	19.61	252.33	30.99	60.29
Average	23.70	25.86	28.52	31.79	34.05

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 12--Anthracite coal: U.S. imports for consumption, by principal sources, 1980-84

Source	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Canada------	1	2	2	2	2
Rep Saf-----	1/	0	1/	0	1
Poland------	5	1	0	0	1
Colomb------	0	0	0	0	1
Indnsia-----	0	0	0	0	0
Japan-------	0	0	0	0	0
U King------	0	0	0	0	1/
Italy-------	0	0	0	0	0
All other---	1/	1/	0	1/	0
Total---	6	3	2	2	5
	Value (1,000 dollars)				
Canada------	31	97	81	97	89
Rep Saf-----	1/	-	1/	-	40
Poland------	153	29	-	-	38
Colomb------	-	-	-	-	24
Indnsia-----	-	-	-	-	1/
Japan-------	-	-	1/	1/	1/
U King------	1/	-	1/	-	1/
Italy-------	-	-	1/	-	1/
All other---	1/	2	1/	3	1/
Total---	184	128	81	100	190
	Unit value (per short ton)				
Canada------	$38.29	$45.58	$45.89	$62.88	$55.78
Rep Saf-----	13.00	-	65.33	-	33.14
Poland------	29.53	46.27	-	-	32.72
Colomb------	-	-	-	-	40.29
Indnsia-----	-	-	-	-	-
Japan-------	-	-	-	-	-
U King------	-	-	-	-	35.00
Italy-------	-	-	-	-	-
All other---	258.00	14.69	-	387.11	-
Average--	30.73	44.21	46.06	64.78	41.93

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 13--Coke: U.S. imports for consumption, by principal sources, 1980-84

Source	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Japan	352	141	39	0	354
France	0	0	0	0	75
Italy	0	0	0	0	54
Canada	116	143	31	23	60
Argent	146	210	49	12	37
Nethlds	0	0	1	0	1
U King	0	9	0	0	1/
Fr Germ	44	0	0	0	1/
All other	1/	25	1/	1/	1/
Total	659	527	120	35	582
	Value (1,000 dollars)				
Japan	31,647	13,047	3,362	-	29,685
France	-	-	-	-	6,637
Italy	-	-	-	-	5,349
Canada	8,568	11,898	2,235	1,628	3,772
Argent	6,826	13,870	3,225	323	1,510
Nethlds	-	-	383	-	121
U King	-	882	-	-	13
Fr Germ	4,323	-	-	-	9
All other	3	2,413	7	1/	2
Total	51,368	42,109	9,212	1,951	47,098
	Unit value (per short ton)				
Japan	$89.86	$92.74	$86.18	-	$83.78
France	-	-	-	-	87.95
Italy	-	-	-	-	98.28
Canada	73.69	83.42	72.07	70.67	63.34
Argent	46.88	66.14	65.59	26.99	40.82
Nethlds	-	-	492.34	-	150.98
U King	-	95.78	-	-	716.17
Fr Germ	97.34	-	-	-	769.67
All other	59.30	97.11	153.68	175.00	144.87
Average	78.00	79.89	76.76	55.75	80.98

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 14 --Other coal and carbonaceous materials: U.S. imports for consumption, by principal sources, 1980-84

Source	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Canada	65	104	81	80	65
Poland	207	25	0	0	98
Rep Saf	1/	0	12	0	48
Colomb	0	0	0	0	23
Japan	0	0	1/	1/	1/
Indnsia	0	0	0	0	1/
U King	1/	0	1/	0	1/
Italy	0	0	1/	0	1/
All other	1/	6	1/	1	1/
Total	272	135	92	81	234
	Value (1,000 dollars)				
Canada	2,558	4,733	3,622	4,410	3,601
Poland	6,113	1,151	-	-	3,351
Rep Saf	1	-	668	-	1,588
Colomb	-	-	-	-	943
Japan	-	-	1/	1	3
Indnsia	-	-	-	-	3
U King	3	-	4	-	1
Italy	-	-	1	-	1
All other	16	87	9	150	2
Total	8,690	5,972	4,305	4,561	9,494
	Unit value (per short ton)				
Canada	$39.24	$45.49	$44.92	$54.82	$55.64
Poland	29.53	46.30	-	-	34.31
Rep Saf	15.29	-	57.10	-	33.13
Colomb	-	-	-	-	40.27
Japan	-	-	240.00	576.00	478.71
Indnsia	-	-	-	-	501.67
U King	90.71	-	432.80	-	41.18
Italy	-	-	29.47	-	117.11
All other	278.03	14.82	212.77	159.95	54.38
Average	31.91	44.30	46.59	56.04	40.60

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

U.S. imports account for less than 1 percent of total U.S. consumption of coal. The following tabulation (derived from tables 9 and 10) indicate the share of total U.S. coal consumption accounted for by imports (in percent):

Import source	1980	1981	1982	1983	1984
Japan	0.05	0.02	0.01	1/	0.04
Republic of South Africa	.11	.11	.08	0.10	.08
Canada	.03	.04	.03	.03	.04
Colombia	0	0	0	.03	.03
France	0	1/	1/	1/	.01
Italy	0	0	1/	0	.01
Poland	.04	.01	0	0	.01
Argentina	.02	.03	2/	2/	2/
All others	.02	.01	2/	.01	2/
Total 3/	.26	.22	.13	.18	.24

1/ Not available because imports were negligible.
2/ Less than 0.01 percent.
3/ Because of rounding, figures may not add to totals shown.

The United States is geographically situated to serve both the European and the Pacific Rim coal markets. U.S. coal is exported from the east coast, the west coast, the Gulf of Mexico, and the Great Lakes via the St. Lawrence Seaway.

U.S. exports of coal and other carbonaceous material increased from 101 million short tons, valued at $5 billion, in 1980 to a record high of 121 million short tons, valued at $6.3 million in 1981 (table 15). This increase in the quantity of U.S. coal exports was attributed to the decreased exports from Poland and Australia as a result of labor problems that disrupted production in those countries. With the end of labor problems in Australia by late 1981, U.S. exports decreased to 116 million short tons, valued at $6.4 billion, in 1982. In 1984, exports were 94 million short tons, valued at $4.7 billion, as Polish mines reopened and the nation reentered the world market.

Coal and port interests have identified the lack of deep-draft coal ports in the United States as a possible constraint on increased U.S. coal exports. They have urged the development of deep-draft coal ports in the United States to maintain competitiveness with other coal-exporting countries. 1/

U.S. exports of bituminous and lignite coals decreased from 90 million short tons, valued at $4.5 billion, in 1980 to 81 million short tons, valued at $4 billion, in 1984 (table 16). U.S. exports of bituminous coal are also divided into steam or metallurgical coals by region as shown in the following tabulation derived from official statistics of the U.S. Department of Energy (in millions of short tons):

1/ For information on U.S. ports, see the Transportation Section of this report.

BLANK PAGE

BLANK PAGE

BLANK PAGE

Table 15--Coal and other carbonaceous material: U.S. exports of domestic merchandise, by principal markets, 1980-84

Market	1980	1981	1982	1983	1984
			Quantity (1,000 short tons)		
Canada	19,132	19,730	19,642	18,396	21,852
Japan	24,927	27,807	28,205	21,427	19,394
Italy	7,695	11,050	12,271	9,521	9,269
Nethlds	6,136	7,799	7,486	5,727	7,668
Belgium	6,028	5,086	6,047	3,994	5,451
Brazil	3,428	2,728	3,149	3,583	4,778
France	8,000	10,335	9,642	5,169	4,500
U King	4,178	2,459	2,112	1,254	2,853
All other	21,423	33,740	27,889	21,351	18,506
Total	100,947	120,733	116,443	90,421	94,272
			Value (1,000 dollars)		
Canada	905,351	1,017,849	1,074,300	972,364	1,139,338
Japan	1,396,935	1,569,613	1,635,447	1,132,895	986,084
Italy	384,740	582,339	678,961	439,843	421,808
Nethlds	278,417	399,550	406,423	281,324	374,028
Belgium	261,649	264,374	332,212	179,475	255,591
Brazil	194,057	165,004	206,446	201,653	250,178
France	368,584	510,783	502,703	233,190	202,196
U King	193,865	133,156	120,901	66,712	152,264
All other	1,053,780	1,700,136	1,483,144	996,278	870,653
Total	5,037,379	6,342,803	6,440,539	4,503,734	4,652,140
			Unit value (per short ton)		
Canada	$47.32	$51.59	$54.69	$52.86	$52.14
Japan	56.04	56.45	57.99	52.87	50.84
Italy	50.00	52.70	55.33	46.20	45.51
Nethlds	45.38	51.23	54.29	49.12	48.78
Belgium	43.41	51.98	54.94	44.94	46.89
Brazil	56.62	60.49	65.55	56.28	52.36
France	46.07	49.42	52.14	45.11	44.94
U King	46.40	54.15	57.23	53.22	53.36
All other	49.19	50.39	53.18	46.66	47.05
Average	49.90	52.54	55.31	49.81	49.35

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 16--Bituminous and lignite coal: U.S. exports of domestic merchandise, by principal markets, 1980-84

Market	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Canada	17,053	17,876	18,249	16,859	20,143
Japan	22,990	25,844	25,768	17,864	16,325
Italy	7,112	10,473	11,279	8,057	7,624
Nethlds	4,530	6,798	5,934	4,162	5,483
Brazil	3,240	2,712	3,110	3,547	4,692
Belgium	4,476	4,162	4,761	2,544	3,902
France	7,523	9,668	8,929	4,143	3,791
U King	4,119	2,341	2,017	1,236	2,853
All other	18,905	30,419	25,251	18,584	15,988
Total	89,947	110,292	105,297	76,996	80,802
	Value (1,000 dollars)				
Canada	807,113	906,553	989,098	888,838	1,037,742
Japan	1,310,776	1,472,562	1,525,615	1,002,073	865,524
Italy	359,638	551,462	636,979	391,622	365,643
Nethlds	208,415	348,586	331,996	226,605	283,690
Brazil	182,247	163,554	203,874	198,944	244,321
Belgium	203,835	220,913	281,045	135,573	201,580
France	341,499	474,704	475,097	204,321	178,763
U King	189,961	127,221	117,285	66,271	152,241
All other	925,347	1,547,831	1,377,195	899,345	761,353
Total	4,528,831	5,813,386	5,938,184	4,013,592	4,090,857
	Unit value (per short ton)				
Canada	$47.33	$50.71	$54.20	$52.72	$51.52
Japan	57.01	56.98	59.21	56.09	53.02
Italy	50.57	52.66	56.48	48.61	47.96
Nethlds	46.01	51.28	55.94	54.44	51.74
Brazil	56.25	60.31	65.55	56.09	52.07
Belgium	45.54	53.08	59.03	53.30	51.66
France	45.39	49.10	53.21	49.32	47.15
U King	46.12	54.35	58.15	53.60	53.36
All other	48.95	50.88	54.54	48.39	47.62
Average	50.35	52.71	56.39	52.13	50.63

Source: Compiled from official statistics of the U.S. Department of Commerce.

Year	European Community	Canada	Japan	All other importers	Total
			Steam coal		
1975	4.4	9.6	0.0	1/	14.1
1976	2.4	9.2	.0	1/	11.6
1977	1.1	10.6	.0	0.1	11.8
1978	.1	9.3	.2	.1	9.6
1979	1.4	11.6	.4	.7	14.1
1980	11.8	10.8	1.0	3.2	26.8
1981	19.3	12.0	3.9	9.7	45.0
1982	17.0	13.3	3.4	6.9	40.7
1983	10.1	10.1	1.7	5.0	26.9
			Metallurgical coal		
1975	10.3	7.2	25.4	8.7	51.6
1976	12.9	7.3	18.8	8.9	47.8
1977	10.2	6.6	15.9	9.3	41.9
1978	7.9	6.0	9.9	6.5	30.2
1979	16.7	7.6	15.3	11.2	50.7
1980	20.5	6.3	22.0	14.4	63.1
1981	22.8	5.8	21.9	14.7	65.2
1982	21.3	4.9	22.4	16.0	64.6
1983	13.4	7.1	16.2	13.3	50.0

1/ Less than 0.05 million short tons.

Anthracite coal exports decreased from 1.8 million short tons, valued at $98 million, in 1980 to 680,000 short tons, valued at $41 million, in 1984 (table 17). U.S. exports of coke increased from 9.2 million short tons, valued at $409 million, in 1980 to 12.7 million short tons, valued at $513 million, in 1984 (table 18). U.S. exports of other carbonaceous materials accounted for less than 1 percent of total coal exports during 1980-84 (table 19).

Research and Development

Currently, research and development (R&D) is taking place in such areas as coal conversion by gasification or liquefaction, as well as synthesis of chemicals from coal. Such R&D efforts are of a long standing nature. Prior to World War II, most synthetic organic chemicals were derived from the byproducts of coal carbonization together with synthesis gas produced from coal gasification. 1/ Crude petroleum and natural gas became the primary domestic organic chemical feedstocks in the late 1940's and remain so today. However, this trend is reversing and one major U.S. chemical producer has

---

1/ Peter James, op. cit., p. 53.

Table 17--Anthracite coal: U.S. exports of domestic merchandise, by principal markets, 1980-84

Market	1980	1981	1982	1983	1984
			Quantity (1,000 short tons)		
Canada	421	361	316	292	301
Kor Rep	541	1,500	550	357	292
Norway	12	6	6	12	38
Venez	10	8	5	6	11
Mexico	11	22	15	4	15
Brazil	26	15	20	25	14
Argent	1/	1	1	1/	2
Turkey	1/	1/	0	0	6
All other	774	335	68	80	2
Total	1,795	2,249	980	776	680
			Value (1,000 dollars)		
Canada	26,077	23,347	23,633	21,985	22,809
Kor Rep	17,517	56,466	19,866	11,578	9,684
Norway	874	565	615	913	2,957
Venez	1,500	1,146	793	1,074	1,853
Mexico	1,066	2,032	1,753	579	1,467
Brazil	1,951	1,394	1,823	2,033	1,137
Argent	4	390	235	95	711
Turkey	7	1	-	-	486
All other	49,292	17,641	4,426	4,906	506
Total	98,289	102,982	53,144	43,163	41,609
			Unit value (per short ton)		
Canada	$62.01	$64.66	$74.81	$75.35	$75.74
Kor Rep	32.40	37.64	36.13	32.41	33.20
Norway	73.79	92.20	102.99	78.66	78.26
Venez	143.36	135.12	152.14	181.04	170.31
Mexico	92.97	90.86	117.81	131.74	99.66
Brazil	75.81	94.04	92.64	80.74	80.73
Argent	272.14	457.52	299.02	325.09	334.92
Turkey	131.16	54.52	-	-	87.52
All other	63.67	52.67	65.42	61.53	206.81
Average	54.76	45.80	54.23	55.61	61.15

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 18--Coke: U.S. exports of domestic merchandise, by principal markets, 1980-84

Market	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Japan	1,858	1,931	2,429	3,562	3,057
Nethlds	1,479	979	1,551	1,565	2,185
Canada	1,626	1,491	1,025	1,166	1,328
Italy	565	577	992	1,464	1,645
Belgium	1,395	833	1,286	1,450	1,549
SPAIN	0	0	0	0	1,024
France	211	589	657	968	709
Kor Rep	39	131	84	160	216
All other	1,998	1,591	2,023	2,206	966
Total	9,171	8,122	10,047	12,541	12,678
	Value (1,000 dollars)				
Japan	79,257	94,985	109,348	130,808	120,053
Nethlds	63,337	49,762	74,417	54,714	90,333
Canada	70,944	87,819	59,850	58,706	74,339
Italy	23,621	30,844	41,982	48,221	56,165
Belgium	49,703	38,688	51,162	43,902	54,011
SPAIN	-	-	-	-	35,906
France	10,320	31,924	24,499	25,612	23,433
Kor Rep	1,265	6,680	3,703	4,996	8,700
All other	110,397	81,529	78,871	75,342	50,269
Total	408,844	422,231	443,833	442,300	513,209
	Unit value (per short ton)				
Japan	$42.65	$49.18	$45.03	$36.72	$39.27
Nethlds	42.82	50.83	47.98	34.96	41.34
Canada	43.64	58.88	58.39	50.37	55.99
Italy	41.83	53.47	42.31	32.94	34.15
Belgium	35.62	46.47	39.77	30.27	34.88
SPAIN	-	-	-	-	35.06
France	48.96	54.18	37.30	26.46	33.07
Kor Rep	32.22	51.14	44.17	31.23	40.24
All other	55.26	51.24	38.99	34.15	52.04
Average	44.58	51.99	44.18	35.27	40.48

Source: Compiled from official statistics of the U.S. Department of Commerce.

Table 19--Other coal and carbonaceous materials: U.S. exports of domestic merchandise, by principal markets, 1980-84

Market	1980	1981	1982	1983	1984
	Quantity (1,000 short tons)				
Canada	33	1	52	80	80
Fr Germ	1/	0	0	26	14
Mexico	1	9	9	2	5
Japan	0	20	8	0	12
Venez	1/	1/	1/	0	1/
Egypt	1/	1/	0	0	1/
Oman	0	0	0	1/	1/
Kuwait	0	0	0	0	1/
All other	1/	40	49	1/	1/
Total	34	70	119	108	111
	Value (1,000 dollars)				
Canada	1,217	129	1,720	2,835	4,448
Fr Germ	14	-	-	1,349	783
Mexico	142	588	879	429	589
Japan	-	986	483	-	507
Venez	29	135	37	-	90
Egypt	2	2	-	-	16
Oman	-	-	-	24	9
Kuwait	-	-	-	-	8
All other	11	2,363	2,259	42	15
Total	1,414	4,204	5,378	4,679	6,464
	Unit value (per short ton)				
Canada	$36.80	$133.85	$32.85	$35.47	$55.44
Fr Germ	133.68	-	-	50.92	55.94
Mexico	137.97	63.62	94.54	283.74	126.87
Japan	-	50.27	57.85	-	41.96
Venez	149.62	428.45	185.35	-	562.50
Egypt	128.33	406.60	-	-	345.60
Oman	-	-	-	227.53	889.70
Kuwait	-	-	-	-	303.78
All other	164.25	58.82	45.98	203.35	95.02
Average	41.03	59.77	45.07	43.22	58.05

1/ Less than 500.

Source: Compiled from official statistics of the U.S. Department of Commerce.

dedicated a world-scale multichemical facility based on coal as the feedstock. 1/

In the United States, R&D in the coal industry is directed toward finding ways to increase the efficiency of coal combustion. 2/ These efforts are concentrated primarily in three areas: (1) fluidized-bed combustion, (FBC); (2) magnetohydrodynamic (MHD) technology; and (3) coal-in-oil suspensions and their use in furnaces designed for oil. FBC involves the feeding of crushed coal into a bed of inert ash mixed with limestone. Among the advantages seen for FBC are its ability to burn a wide range of coals, a solid waste more easily disposed of, and its reduced emissions of sulfur and nitrogen oxides--mainly as the dioxides.

FBC is envisioned as particularly useful for small, industrial facilities that are subject to strict emission standards. However, FBC is a relatively new technology and has the potential for problems which are not common in current facilities, and it has not proven itself commercially in conventional operations.

MHD technology offers the potential for producing electricity directly from hot combustion gases without the need for steam or gas turbines. MHD coal-fired units present a special problem because of the potential for ash slag building up on the walls of the system.

Coal-oil mixtures have been available since the late 1800's but were not used significantly until World War I. These coal-petroleum mixtures, generally of 20 to 50 percent coal, have received increasing attention since the mid-1970's as a means of reducing imports of petroleum used in petroleum-fired boilers. The formation of slag from ash, combustion behavior, and the stability of the mixture in storage and transport are among the important factors requiring careful study before commercializing coal-oil mixtures.

Official statistics on R&D expenditures are limited to those companies that report to official sources under the Financial Reporting System (FRS). 3/ In 1984, there were 26 major energy companies that annually reported their financial and operating developments under the FRS. The FRS companies are an important source of coal domestically, accounting for 23 percent of U.S. coal production (excluding anthracite).

Worldwide R&D expenditures by FRS companies for conventional coal projects increased from $36.0 million in 1981 to $45.7 million in 1982, or by

---

1/ "Eastman Unveils 'Coal Chemicals' Facilities," Chemical Marketing Reporter, Apr. 9, 1984, pp. 3 and 16; and, "Eastman Claims Syngas-to-Acetic Anhydride Facility is Economic," European Chemical News, Apr. 13, 1984, p. 14.

2/ Carrol L. Wilson op.cit., pp. 185-198; and, U.S. Office of Technology, The Direct Use of Coal: Prospects and Problems of Production and Combustion, April 1979, pp. 100-105.

3/ U.S. Department of Energy, Performance Profiles of Major Energy Producers 1982, July 1983, pp. 3, 50, 105-106, 112-113, 115-116, and 200; "How Will Coal be Affected by Oil-Price Reductions," The OECD Observer, No. 122, May 1983, pp. 21-22.

27.2 percent. However, R&D expenditures for coal gasification/liquefaction declined by $45 million, or 16.8 percent, from $268.4 million in 1981 to $223.4 million in 1982. 1/ This cutback in R&D outlay is attributed by trade sources primarily to a reduction in the price for crude petroleum and lowered expectations for future crude petroleum prices. These factors make it uneconomical to convert coal into a gaseous or liquid form to penetrate markets, such as transport fuels, now held by crude petroleum, natural gas, and their derivatives. 2/

In addition, domestic capital outlays for coal gasification/liquefaction and tar sands declined by more than 86 percent, from $38.1 million in 1981 to only $5.2 million in 1982. 3/ This decline also is attributed primarily to the drop during 1981-82 in crude petroleum prices, which went from an actual domestic average wellhead price of $31.77 per barrel in 1981 to $28.52 in 1982. 4/

Coal Technology

Coal gasification and liquefaction are currently being examined as processes for production of synthetic fuels. Most gasification and liquefaction operations are in the planning or engineering stage or at the pilot stage. Coal-methanol is also being studied for use as fuel.

Coal gasification

The Lurgi fixed-coal bed gasifier was first operated in Germany in 1936. The principle involved in coal gasification is the reaction of coal with air, oxygen, steam, carbon dioxide, or a mixture of all four to produce carbon monoxide and hydrogen (and methane under certain conditions). The product can be used for fuel or as a chemical raw material. Coal gasification produces a low-Btu-value gas called producer gas by reacting coal with air and steam; a high-heating-value gas (500 Btu's per cubic foot), synthesis gas, is produced from the reaction of coal with oxygen and steam.

There are three basic types of coal gasification, with many experimental and theoretical variations:

1. Fixed-bed gasification uses a grate to support the coal and countercurrent or cocurrent flow of gas and coal. The process can occur at atmospheric pressure or at higher pressures (Lurgi gasifier) and uses air or oxygen and steam;

2. Fluidized bed gasifiers use crushed coal, oxygen or air, and steam at high termperatures and with some pressure. The coal particles are fluidized by the oxygen and steam; and,

---

1/ Ibid.
2/ Ibid.
3/ These are defined as additions to property, plant, and equipment.
4/ U.S. Department of Energy, Monthly Energy Review, February 1984, p. 84.

3. Entrained bed or suspension gasifier is where coal particles are suspended in the oxygen steam and move in a vortex. The traditional fixed-bed gasifier has a relatively large-coal-sized requirement; while the fluidized and suspension gasifiers will accept fine particles of coal.

Coal liquefaction

Coal liquefaction produces liquid fuels from coal by increasing the hydrogen-to-carbon ratio of the coal to approximate that of petroleum. There are three basic coal liquefaction processes:

1. The pyrolysis method involves heating coal to successively higher temperatures to the point where it decomposes, giving off liquids and gases higher in hydrogen content than the coal;

2. The extraction hydrogenation adds hydrogen to coal and removes carbon by several different methods. In one method, a coal slurry enters a reaction in which the coal is dissolved and reacted. Reaction products are cooled, then separated into gases and liquids; the solids can be separated from the liquids by filtration; the indirect liquefaction process (catalytic hydrogenation of carbon monoxide) is where coal is first gasified using an entrained bed gasifier; the gases are cleaned and then fed to two different reactions depending on the desired product. The Fischer-Tropsch reaction gives hydrocarbons, alcohols, and other chemicals, and the methanol reaction gives methanol; and,

3) Direct hydrogenation allows conversion of coal to gases, liquids, and solids to be used as fuels and feedstocks. The process involves a liquid-phase step that yields light oils, followed by a vapor-phase step in which some of the product from the liquid-phase step is converted to gasoline.

Coal-Methanol Motor Fuel

One possible future use for coal is to produce methanol that, in turn, would be used as a blending stock in motor gasoline. The United States and other methanol-producing countries are faced with a situation of oversupply of methanol capacity, and this overcapacity is expected to increase as additional methanol capacity comes onstream in conventional-energy-rich nations. 1/

1/ U.S. International Trade Commission, The Probable Impact on the U.S. Petrochemicals Industry of the Expanding Petrochemical Industries in Conventional-Energy-Rich Nations, USITC Publication No. 1370, April 1983.

One possible use for excess methanol capacity is the fuel market. About 8 percent of total U.S. methanol consumption (or 280,000 to 300,000 metric tons) was used in the fuel market in 1983. 1/ Methanol-gasoline blends have certain advantages. Prices for methanol were about 42 cents per gallon in 1983 versus $1.22 for motor gasoline. 2/ It is possible to use low percentages of methanol in unleaded gasoline with little or no modification to conventional cars.

Straight methanol has long been a preferred fuel for racing engines because methanol has combustion ratios compared with gasoline. Pure methanol has a research octane number (RON) of 109.6 and a motor octane number (MON) of 87.4. Motor gasoline (unleaded) has a RON of 98.9 and a MON of 91.4.

However, a methanol-gasoline blend has moisture problems. Even minute amounts of moisture destabilize the methanol-gasoline mixture. Metal corrosion becomes a serious problem when phase separation occurs. When cosolvent alcohols are added to methanol, its water tolerance improves markedly.

Methanol blends require an Environmental Protection Agency (EPA) waiver from the provisions of the Clean Air Act. Section 211(f) of that act prohibits selling new unleaded fuels or fuel additives in unleaded fuels without EPA approval. EPA will grant waivers if it is satisfied that the fuel or additive will not cause violations of vehicle emission standards. Several methanol waivers have been granted and several have been denied.

Economically, methanol at 42 cents per gallon equals about 68 cents per gallon as a gasoline extender on a Btu-equivalency basis compared with 82 cents per gallon for refinery gasoline. 3/ On a dollars-per-barrel basis, methanol has a cost advantage ratio of $1 to $2 over unleaded gasoline. Additional value has to be credited to methanol for its higher octane rating. Refiners will be increasingly hard pressed to find additional octane, as older cars on the road are replaced by new ones, which require unleaded gasoline. Even without the accelerated lead phasedown that EPA is considering, leaded gasoline could represent only 20 percent of the market by early the 1990s. Its share was 46 percent in 1983 and 66 percent in 1978. 3/

Transportation

The U.S. coal transportation network is made up of railroads, waterways, ports, trucks, and slurry pipelines. About 65 percent of U.S. coal is

---

1/ "Large Volume Fuel Market Still Eludes Methanol," Chemical & Engineering News, July 16, 1984, p. 10.

2/ U.S. Department of Energy, Monthly Energy Review, June 1984, p. 96. (Leaded regular gasoline in 1983 was $1.16 per gallon; unleaded regular, $1.25 per gallon; and unleaded premium, $1.38 per gallon.)

3/ "Large Volume Fuel Market Still Eludes Methanol," Chemical & Engineering News, July 16, 1984, p. 13.

transported by rail, 13 percent by trucks, 21 percent via waterways (ships and barges), and about 1 percent by slurry pipelines.

Some railroads have taken steps to increase capacity to handle export coal. Coal bound for Atlantic coast ports moves primarily by rail. Coal bound for the gulf coast ports can be moved by railroad and waterway systems, either separately or in combination. Rail lines already link the western coal-producing States to the major west coast port areas. Although these lines do not currently carry large volumes of coal, they could be able to handle projected export coal traffic if large commitments by foreign coal buyers are finalized. Figure 1 shows the principal U.S. coal basins and rail plus waterway routes to U.S. ports.

Railroads

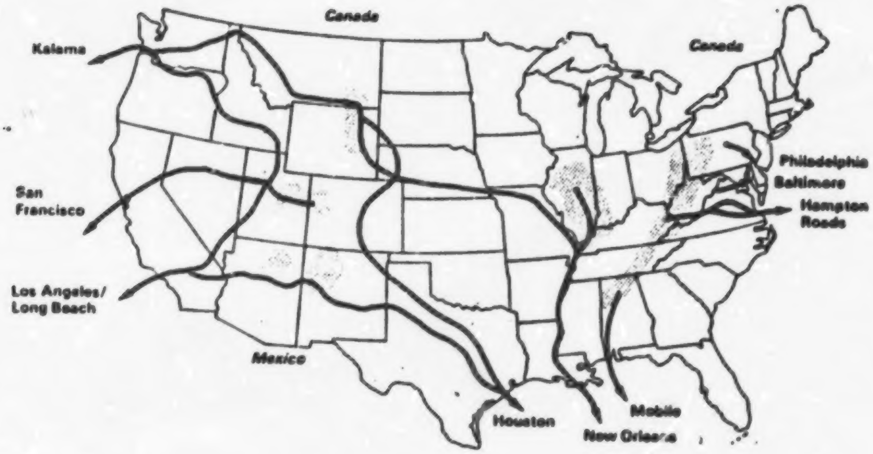
Railroads are the principal mode of coal transportation, ranging from a high of 71 percent of shipments in 1970 to a low of 61 percent in 1978. Recently, more coal is moved by unit trains, which are generally a set of haulage equipment used exclusively to haul coal. Unit trains usually operate in 100-car units, move between one origin and one destination per trip, and travel on a predetermined schedule.

In 1980, after the deregulation of the airline and trucking industries, Congress passed the Staggers Rail Act, which allowed railroads to operate in a freer market system. Under the act, coal shippers (e.g., coal producers and consumers) were, for the first time, permitted to enter into contracts with railroads for rates and services. These contracts are subject to a limited review by the ICC to ensure that the common carrier obligations are not inhibited by the contract.

The Staggers Act substantially changed the process by which the ICC sets maximum reasonable rates. Instead of the system of industrywide general rate increases in effect until April 1, 1982, the act authorized carriers to increase individual rates in response to inflationary costs, with minimal ICC review. For the first 4 years after enactment, rates were allowed to be raised by up to 6 percent per year above the rate of inflation as measured by the Railroad Cost Recovery Index, with a cumulative maximum of 18 percent. After the first 4 years, those carriers not earning adequate revenues, as determined by the ICC, will be allowed to raise rates by 4 percent annually above the cost-related increases. These rates are referred to as the "zone-of-rate flexibility." Shippers may contest these rate increases once they have gone into effect. However, the ICC cannot suspend such rates, but only investigate increases that are more than 20 percentage points above the threshold. The impact of these changes has been to shift the burden of proving the rate as unreasonably high from the carrier to the shipper.

Recent ICC actions indicate the possibility that most remaining coal-hauling rates could be deregulated. A February 1983 proposal by the ICC on nationwide coal-rate guidelines would allow railroads to increase their rates by up to 15 percent per year to earn enough profit to remain a viable

Figure 1.--Principal U.S. coal basins and rail and waterway routes to coal ports


Canada
Kalama
Canada
Philadelphia
Baltimore
San Francisco
Hampton Roads
Los Angeles/ Long Beach
Mexico
Mobile
Houston
New Orleans

Source: Interagency Coal Export Task Force, Interim Report of the Interagency Coal Export Task Force, January 1981.

entity. 1/ The following tabulation, derived from official statistics of the U.S. Department of Energy (DOE), shows the possible decreases in U.S. coal production and exports that could result from the ICC's projection of material average rail increases:

Year	ICC's projections of national rail price increase	DOE's projections of decreases in U.S. production/ exports
	Percent	Million short tons
1985	29	20.9/14.9
1990	71	53.7/27.2
1995	90	70.0/36.6

The ICC deregulated rail rates for export coal in September 1983. As a result, export-coal rail rates vary considerably on the basis of topography of routes and alternative routes available to the shipper. In January 1984, U.S. single car rates for export coal ranged from $12.03 per short ton to $22.34 per short ton. 2/

Ports

Most U.S. coal exports move through several ports. The major Atlantic coast, ports are Philadelphia, Baltimore, and Norfolk and Newport News, which are referred to as Hampton Roads. The major Gulf coast ports are Mobile and New Orleans.

In addition to these facilities, multipurpose bulk terminals at Baton Rouge, Los Angeles, and Long Beach ship small amounts of coal. There are also several coal terminals with large capacities on the Great Lakes that ship coal to Canada. Owing to lock and channel restrictions on ship size along the St. Lawrence Seaway, direct shipment from these ports to Europe and Japan is considered less economical than deep-water ports on the Atlantic and Gulf coasts.

Hampton Roads, VA, is the largest coal-exporting port, accounting for almost one-half of total U.S. coal exports. The port has an effective capacity of 73.8 million short tons over five piers (two in Norfolk and three in Newport News). Hampton Roads has a depth of 45 feet, and there are plans to deepen the port to 55 feet in order to accommodate deep-draft colliers.

1/ U.S. Department of Energy, 1983 Annual Outlook for U.S. Coal, November 1983, p. 21.

2/ Coal Week International, Jan. 18, 1984.

The Port of Baltimore is the third largest U.S. coal port. The annual capacity in Baltimore is 26.6 million tons. Baltimore is the only U.S. port that has been congressionally approved to deepen its channel from 42 feet to 50 feet (in 1970); however, construction is still awaiting funding.

The Port of New Orleans is the next largest coal-exporting port and the principal Gulf coast port for coal. New Orleans has an effective capacity of about 31 million tons and a channel depth of 40 feet. It is proposed to dredge the New Orleans port to 55 feet. The Port of Mobile, also on the Gulf coast, has an effective capacity of 25 million tons and has proposed to deepen its channel from 40 to 55 feet.

The west coast ports in California at Los Angeles, with a depth of 51 feet, and Long Beach, with a depth of 60 feet, are the only U.S. deep-draft ports. Proposals have been made to deepen their common entrance channel to 80 feet.

Philadelphia the seventh largest coal-exporting port, has the capacity to export 15 million tons of coal per year but exports only about 1 million to 3 million tons per year. The port has a channel depth of 40 feet and there are no plans to dredge it.

The following tabulation, derived from official statistics of the U.S. DOE, shows the above seven U.S. ports and their exports of bituminous coal in 1982 (in thousands of short tons):

Port	Quantity
Hampton Roads	57,820
Great Lakes	18,104
Baltimore	11,747
New Orleans	7,674
Mobile	4,269
Los Angeles/Long Beach	2,833
Philadelphia	1,516
All others	1,282
Total	105,244

A consideration in port capacity is the distinction between metallurgical and steam coal. The Hampton Roads and Baltimore ports were designed to handle metallurgical coal, which involves the maintenance of hundreds of separate types of coal in hopper cars and requisite blending equipment. Requirements are less severe for steam coal. A steam coal port combines ground storage and special stocking and reclamation equipment with special equipment to handle unit trains.

Historically, the Federal Government has borne the costs of deepening and maintaining the channel depths of U.S. ports. 1/ In the interest of reducing

---

1/ U.S. Department of Energy, Port Deepening and User Fees Impact on U.S. Coal Exports, May 1983, p. vii.

Federal deficits, the administration and Congress have proposed legislation to share the entire cost or some portion of the cost of port deepening with those who benefit most from the use of the ports. 1/ Under the proposed cost-sharing arrangements with the Federal Government, the local port authorities would be allowed to impose user fees to defray these costs. The administration and Congress have proposed legislation that sets forth alternative methods of calculating user fees for both maintaining and deepening U.S. port channels.

The current capacity of U.S. coal ports is reported to be sufficient to handle the projected levels of U.S. coal exports during the next two decades. However, in contrast to other major coal-exporting and coal-importing countries whose ports can accommodate large, deep-draft colliers, the channel depths of major U.S. coal ports restrict the United States to the use of vessels of 60,000 deadweight tons (dwt) or less. 2/

For example, Australia has four coal ports, each with a channel depth at least 53 feet and an effective capacity of 88 million short tons per year. Australia is building another deep-draft coal port with an effective annual capacity of 11 million short tons. Australia exports about 40 million short tons of coal per year to the Pacific Rim. 3/

South Africa has a coal terminal with a 56-foot depth from which 28 million short tons of coal can be exported annually. South Africa has plans to increase its export capacity to 72 million short tons annually and deepen the port to handle 250,000-dwt ships. 4/

Poland has four Baltic Sea ports, with a total annual export capacity of 33 million short tons of coal. The ports, however, have channel depths of 49 feet or less, which can only handle ships of less than 100,000 dwt. Because of Poland's proximity to Western Europe, it is unlikely that plans will be developed to dredge the ports. 5/

Barges

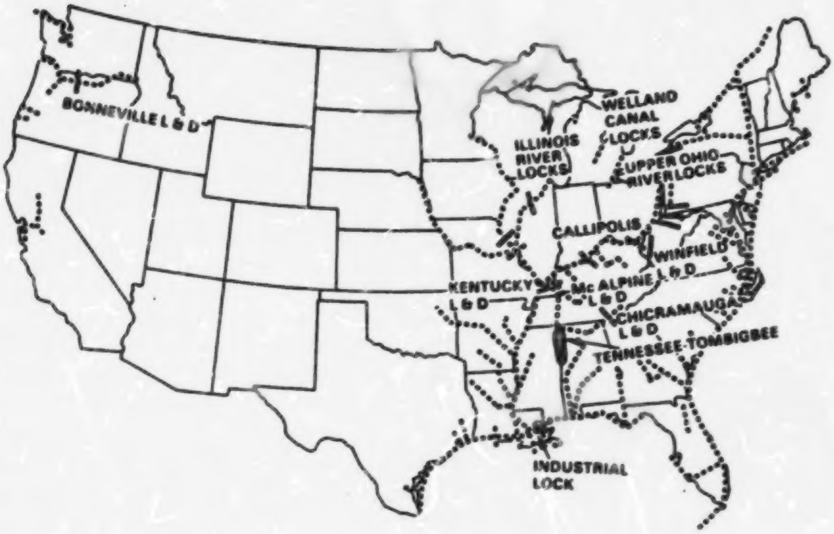
Barge transportation can be used either as the sole mode of transportation or in conjunction with rail and/or truck shipment. Most of the inland waterways, locks, and harbors used in barge transportation are maintained by the Army Corps of Engineers. Figure 2 shows the waterway system and principal lock and dam constraints relating to coal traffic.

Trucks

Transportation of coal by truck is used primarily to link smaller coal mines with railroads and inland piers. The U.S. trucking industry was deregulated in 1980.

1/ Ibid.
2/ Ibid.
3/ Ibid., p. 6.
4/ Ibid.
5/ Ibid.

Figure 2.--U.S. waterway system and principal locks and dams for coal transportation


BONNEVILLE L & D
WELLAND CANAL LOCKS
ILLINOIS RIVER LOCKS
UPPER OHIO RIVER LOCKS
GALLIPOLIS
WINFIELD L & D
KENTUCKY L & D
Mc ALPINE L & D
CHICRAMAUGA L & D
TENNESSEE-TOMBIGBEE
INDUSTRIAL LOCK

Source: Interagency Coal Export Task Force, Interim Report of the Interagency Coal Export Task Force, January 1981.

Slurry Pipelines

An alternative to rail or waterborne inland transport of export coal is a slurry pipeline system, wherein coal is pulverized and the particles suspended in a fluid transport medium for movement using conventional hydraulic technology. The pipeline may be part of a total slurry transport system employing special slurry-handling ocean terminals and ships, or it may form the overland segment of a typical dry-bulk-shipping system. Among the advantages of a coal-slurry pipeline are clean, quiet operation; energy efficiency; protection from weather extremes; and less vulnerability to effects of inflation on transport costs.

As figure 3 indicates, two coal slurry pipelines have been built and put into operation for movement of domestic coal. The Black Mesa Pipeline has carried about 4 million tons of coal per year from Kayenta, AZ, to southern Nevada, a distance of 273 miles. From 1957 to 1963, the 108-mile Ohio Pipeline operated from Cadiz, OH, to Cleveland, OH, but this pipeline was closed after the introduction of competing unit trains. Neither pipeline has a location suitable for export coal.

Of the eight proposed coal-slurry pipelines (fig. 3), five would have a potential capacity for export coal. Two pipelines would each have the capacity to export about 10 million tons annually. The other three would have the capacity to export less than 1-million tons each.

Potential barriers to the further development of slurry pipelines include difficulty in obtaining access to adequate quantities of water, which are subject to State control; large initial investments by both U.S. shippers and foreign receivers; environmental objections; multijurisdiction review procedures; and opposition from railroads, which may be able to prevent the pipelines from traversing the railroads' rights of way.

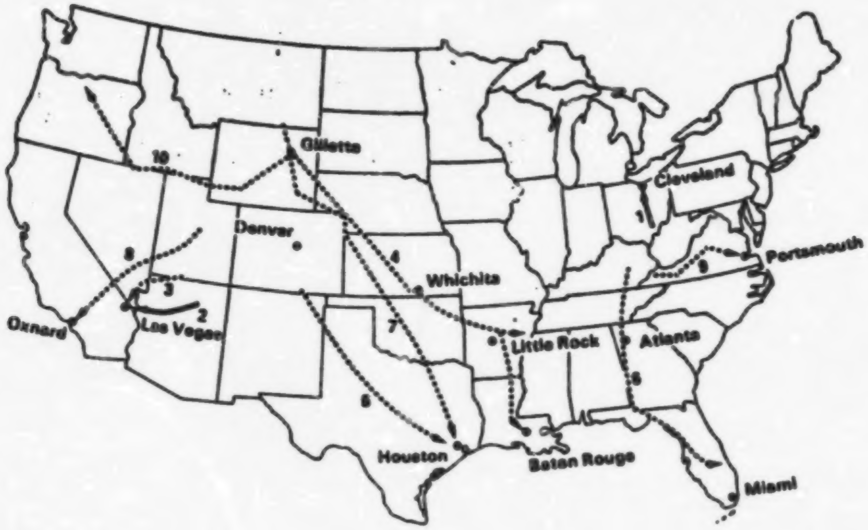
Coal producers and users are looking to the pipelines as a competitive alternative to the railroads. Although there may be problems regarding the potential profitability of the pipeline systems, environmental considerations and water availability, the pipelines remain a potential source of competition to rail transportation of coal. Coal-slurry pipeline companies contend that they can transport large volumes of coal economically and efficiently over long distances; however, they require lead times for construction and for assembling rights of way and water rights. Based on currently proposed coal slurry pipeline projects, the U.S. DOE estimates potential future slurry pipeline capacity could be as high as 150 million tons per year by 2000. Coal slurry pipelines, however, are expected to play only a minor role in transporting coal through 1990.

CURRENT AND ANTICIPATED INDUSTRY STATUS IN OTHER COAL-RICH NATIONS

World Reserves and Production

North America, particularly the United States, leads the rest of the world in total reserves and production of coal. The United States accounts

Figure 3.--Existing and proposed coal slurry pipelines


Gillette
10
Cleveland
1
Denver
8
Portsmouth
9
4
Whichita
3
2
Oxnard
Las Vegas
7
Little Rock
Atlanta
6
5
Houston
Baton Rouge
Miami

______ Existing Pipelines

------ Planned or Proposed Pipelines

Source: Interagency Coal Export Task Force, Interim Report of the Interagency Coal Export Task Force, January 1981.

for 28 percent of the world's recoverable reserves, followed by the Union of Soviet Socialist Republics (U.S.S.R.) and the People's Republic of China (China). The next largest reserves are in the United Kingdom with 7 percent of the world's total reserves. The United States accounts for approximately 21 percent of the world's production of coal, again followed by the U.S.S.R. and China, and the EC accounts for about 11 percent. The following tabulation shows the average percentage of total world reserves and production by country during 1980-84:

Country	Total world reserves	Total world production
	Percent	
United States	28	21
U.S.S.R	24	19
China	14	16
United Kingdom	7	3
Australia	6	4
Federal Republic of Germany	5	6
Poland	4	6
Republic of South Africa	4	5
All others	8	20
Total	100	100

Australia, the EC nations of West Germany and the United Kingdom, South Africa, and the nonmarket economies have an advantageous position compared with certain other coal-rich nations, not only in terms of coal resources, but also in terms of the infrastructure necessary to produce and export coal to the world markets. There are many other nations that possess coal resources and currently export coal, and certain of these could become world-scale producers and exporters in the near term. 1/

Australia

Reserves

Australia has large deposits of bituminous and sub-bituminous coal. Reserves of bituminous and sub-bituminous coal are estimated at 48.6 billion tons. Of these reserves, 57 percent are recoverable reserves. An additional 607.6 billion tons of coal are considered resources in place but currently uneconomical to mine. The following tabulation shows the coal reserves, by categories and by area (in millions of tons): 2/

1/ Coal Age, November 1983, pp. 50-54.

2/ World Coal Study (WOCOL), Future Coal Prospects, Country and Regional Assessments, 1980, p. 20.

Area	Proved reserves	Proved recoverable reserves	Additional reserves in place
New South Wales	22,743	12,122	490,036
Queensland	24,476	14,650	112,900
Western Australia	204	161	2,087
South Australia	720	720	2,300
Tasmania	139	69	200
Total	48,552	27,722	607,523

There are also reserves of about 123 billion tons of lignite coal (or "brown coal") found in Victoria. The average moisture content of this coal is about 62 percent and has a low heating value. 1/

Production

Australia has increased coal production steadily since the early 1960's. The following tabulation shows Australia's coal production for selected years (in millions of tons): 2/

Year	Production
1960	38
1965	53
1970	74
1975	95
1977	110
1979	127
1980	128
1981	137
1982	143
1983 1/	149
1984 2/	141

1/ Estimated.
2/ Estimated, based on 3 months of production.

Most of the coal produced is sub-bituminous or black coal. Production of black coal increased from 96 million tons in 1980 to 114 million tons in 1983. 3/

The mines in New South Wales account for about 55 percent of Australia's coal production. Most of this coal is produced in underground mines. The

---

1/ Ibid., p. 22.
2/ WOCOL, op. cit., pp. 22-24, and U.S. Department of State, Airgram, "Major Energy Statistics," No. A-116, July 17, 1984, p. 17.
3/ Ibid.

Queensland mines account for about 45 percent of total coal production, almost entirely from surface mines.

Importance to the Economy

Coal has been important to the development of Australia's economy from the early 19th century as a major source of energy and a major export item. The development of Australia's coal industry slowed somewhat in the 1950's, with the startup of the refining industry to utilize the nation's large reserves of crude petroleum. However, by the 1960's, the coal industry again grew with the mechanization of mining practices.

Large sections of the coal industry are dependent on the export market. Many mines and the infrastructure associated with them have been developed to respond to export contracts. As a result, new coal projects are dependent upon increased demand in the export market.

Employment in the coal industry increased by nearly 50 percent during 1970-80, to about 24,500 workers. 1/ Labor productivity at surface mines is about 30 tons per shift and about 10 tons per shift for underground mines, which is comparable with productivity in the United States. 2/ The miners work a 35-hour week, and wages are high vis-a-vis those of other exporting nations (excluding the United States). 3/

Although industrial relations in the coal industry historically have been difficult, especially during the late 1940's and early 1950's, the situation has eased in recent decades. In New South Wales, days lost as a result of disputes amounted to only 3.3 percent in 1976-77 compared with 18.3 percent in 1949-50. Output stood at 12.4 tons per person per shift in New South Wales and 16.4 tons in Queensland in 1979, one of the highest levels in the world. However, extensive strikes in the summer of 1980 reopened doubts in some foreign markets, particularly Japan, as to the reliability of Australian exports. Some observers are concerned that shortages of skilled labor may also hamper the coal industry's expansion, although some remedial action has been taken by both the Federal and State Governments. 4/

Consumption

Coal accounted for about 41 to 43 percent of Australia's total energy requirements during 1973-81 and could increase to 45 percent by 1990. 5/ Crude petroleum currently accounts for 45 percent of Australia's energy requirements

---

1/ WOCOL, op. cit., p. 23.

2/ Ibid.

3/ Ibid.

4/ The Chase Manhattan Bank, The Coal Situation, vol. 1, No. 3., March 1981, p. 2.

5/ International Energy Agency, Coal Information Report, 1983, p. 152.

and could decrease to 33 percent by 1990 as Australia relies more on coal as an energy source. 1/

In 1981, exports accounted for about 48 percent of Australia's coal production, and the industrial sector accounted for about 12 percent. 2/ In 1981, the electricity generating sector accounted for about 32 percent of production. The following tabulation shows the percentage of total coal production consumed, by sectors, during 1978-81: 3/

Sector	1978	1979	1980	1981
Exports	45.0	46.0	47.0	48.0
Electricity generation	35.0	36.0	38.0	33.0
Industry:				
Iron and steel	6.0	6.0	6.0	4.0
Petrochemicals/chemicals	0.3	0.3	0.2	0.1
Other	9.0	8.0	8.0	7.0
Transportation	-	-	-	-
Other	4.7	3.7	0.8	7.9
Total	100.0	100.0	100.0	100.0

Industry Structure

The Federal Department of Minerals and Energy has the responsibility for coal development. The State Department of Mines and the Department of Minerals and Energy provide tax incentives for the development of mines and the infrastructure needed to transport the coal produced. There is a widespread acceptance that Australian ownership and control of the coal industry is needed; however, foreign participation in the industry is allowed up to 50 percent, with 50 percent local participation. 4/ More than 50 percent foreign participation requires a demonstration that Australian participation is unavailable and that the development in question will facilitate increased access to foreign markets. 5/ Most of the foreign participation is by petroleum or mining companies. Recently, several projects have been delayed awaiting local participation. 6/ Areas with substantial foreign investment include mines in both Queensland and New South Wales.

The Australian Government and Australian privately owned companies are brought together through the Joint Coal Board of New South Wales and the

---

1/ Ibid.
2/ Ibid., p. 153.
3/ Ibid.
4/ WOCOL, op.cit., p. 6.
5/ Ibid.
6/ Ibid, p. 8.

Queensland Coal Board. These boards handle the administrative duties involved in mine development. The industry is made up of many types of companies. For example, about 20 percent of bituminous coal production and all the lignite are produced captively for the New South Wales Electricity Commission, the State Electricity Commission of Victoria, and some domestic steel producers.

Scientific and technical work has been encouraged by the Government since 1977. Most research is done by the Australian Coal Industry Research Association.

Trade

Australia does not import coal, but relies on domestic production to satisfy domestic demand.

Australia exports nearly 50 percent of its total coal production. Most of these exports are metallurgical coals. The following tabulation shows Australia's exports of metallurgical and steam coal during 1980-84 (in millions of metric tons): 1/

Year	Metallurgical coal	Steam coal	Total
1980	35.1	7.7	42.8
1981	40.8	10.2	51.0
1982	37.1	12.7	49.8
1983	41.3	18.3	59.6
1984 1/	42.5-44.2	19.4-21.7	61.9-65.9

1/ Estimated.

The major market for Australian coal is Japan, accounting for nearly 50 percent of total exports. Other markets include the EC-member nations of France, West Germany, the Netherlands, and the United Kingdom.

West Germany

Reserves

West Germany has large lignite and hard coal deposits. The reserves of each total approximately 55 billion and 230 billion tons, respectively, of which 65 percent of the lignite reserves and 10 percent of the hard coal reserves are considered to be economically and technically recoverable reserves.

1/ The Chase Manhattan Bank, The Coal Situation, vol. 2., No. 3., March 1982, p. 3 and vol. 4., No. 2, March 1984, p. 3.

The majority of the lignite reserves are concentrated in the Rhenish coal field, west of Cologne. This field produced 81 percent of the lignite mined in West Germany in 1979.

The Ruhr and the Saar Basins contain the largest reserves of hard coal. Eighty percent of the domestic hard coal production was mined in the Ruhr Basin. 1/

In 1980, West Germany accounted for 4.9 percent of the world's recoverable reserves of anthracite and bituminous coal and 14 percent of the world's recoverable reserves of lignite. 2/

Production

Production of coal in West Germany declined between 1960 and 1977 as a result of increased domestic consumption of crude petroleum and natural gas. Hard coal output dropped to 91.9 million tons in 1977, down by 40 percent from that in 1960. Employment declined from 600,000 workers in 1960 to 180,000 workers in 1977. Lignite production increased from 85 million tons in 1960 to 115.6 million tons in 1977, because of the lower cost of surface mining. In 1977, the second version of the Energy Program of 1973 was issued, which called for the stabilization of the production of lignite at 1977 levels.

The production of hard coal rose from 91 million metric tons in 1978 to 93 million metric tons in 1979. This was the first year-to-year increase since the initiation of the energy program. Lignite production in 1979 totaled 130.6 million metric tons, or about 60 percent of total coal production.

West German hard coal is mined from underground mines. It was estimated that in 1979 each of the hard coal industry's 182,000 workers produced a face output of up to 20 tons per shift. In spite of this high productivity, production costs were high, mainly because of poor geological conditions (thin seams and great depths) and the high value of the deutsche mark. 3/

Production of hard coal increased during the next 2 years. In 1981, 95 million metric tons were mined, an increase of 1 percent from 1980. Lignite production remained fairly constant during the period at 129.9 million metric tons in 1980 and 130.7 million metric tons in 1981.

Production in the Ruhr mining zone has been moving northward since 1956 as older mines near depletion. In 1956, 50 percent of production came from the southern position of the field compared with 10 percent in 1979. Virgin coal reserves exist north of the area presently being mined. Further hard coal reserves are also available at depths below the usual mining level of 1,000 meters. Increased heat, which leads to mine deterioration, is one of

---

1/ Robert P. Green, and J. Michael Gallagher, eds., Future Coal Prospects: Country and Regional Assessments, Ballinger Publishing Co., 1980, p. 160.

2/ Peter James, The Future of Coal, The MacMillan Press Ltd., 1982, p. 14.

3/ Ibid., p. 192.

the main problems associated with deeper mines. This can be controlled by mine air cooling, shorter work hours, and stringent medical controls.

The Rhenish field contains many older mines that are near depletion. Production is supplemented mainly by the Hambach Forest, where mine development started in 1978. To avoid environmental damage, particularly since major cities are in close proximity to the surface-mined areas, efforts are expected to be made to modernize mining methods by the end of the century rather than to increase the surface areas.

Importance to the Economy

Coal is expected to play an increasingly important role in West Germany as efforts are made to diminish the country's growing reliance on imported crude petroleum and natural gas. 1/ In 1981 and 1982, West Germany experienced an economic downturn that resulted in a decline in the domestic primary energy consumption. Although crude petroleum and natural gas consumption declined, coal consumption remained fairly constant, as the result of the Energy Program issued in 1973, which studied alternative sources to imported crude petroleum, principally coal and nuclear power. Economic incentives were implemented, including the purchase of 33 million metric tons per year through 1987 by the electricity-generating sector.

In 1980, a more comprehensive plan, "The Agreement of the Century," called for utilities to increase their purchases of coal by approximately 17 million tons every 5 years until 1995, when the amount purchased would reach about 160 million tons. This agreement resulted in the relaxation of the import quota system for coal that had been in effect since 1959 and was based on Article 19 of the General Agreement on Tariffs and Trade (GATT) Convention and the Foreign Trade Act. 2/ Under the new plan, utilities would be allowed to burn 1 ton of coal imported from nonmember EC countries for every 2 tons of domestic coal burned above 33 million tons per year between 1981 and 1987 and for every ton of domestic coal burned after 1987. 3/

Concern over strengthening the domestic coal industry increased as a result of rising energy prices and the 1973-74 crude petroleum embargo. Industrial consumption of crude petroleum had climbed by 333 percent to 660 million tons between 1960 and 1977, and natural gas consumption increased by 55 percent to 190 million tons in 1977. Increased imports were necessary to supplement a limited domestic supply of crude petroleum and natural gas. 4/ Crude petroleum accounted for 52.1 percent of the primary energy consumption in 1977, of which 96 percent was imported, mostly from Organization of Petroleum Exporting Countries (OPEC). Natural gas represented 14.9 percent of primary energy consumption in 1977. The crude petroleum embargo in 1979 served to further increase interest in rebuilding the coal industry. 5/

1/ Robert Greene and J. Michael Gallagher, op. cit., p. 153.

2/ Proceedings, Coal Outlook's International Coal Trade Conference, Presentation of Eckhard Albrecht, May 1982.

3/ Peter James, op. cit., p. 194.

4/ Robert Greene and J. Michael Gallagher, op. cit., p. 155.

5/ Ibid.

Consumption

West Germany consumed 271 million metric tons of coal in 1977, of which 91 percent was produced domestically; the remainder was imported mainly from nonmember countries of the EC. The imported coal was consumed mainly by the steel plants.

Most of the domestic coal is used in the domestic electricity and steel sectors. About 90 percent of the lignite produced in 1977 was used in power plants. The other 10 percent was briquetted and sold mainly to households and small consumers. Industry purchased about 2 million tons of the briquetted lignite.

Power plants consumed 35 percent of the hard coal produced in 1977. The iron and steel sector used 25 percent, and 12 percent was sold to households, industries, and small consumers. The remainder of the hard coal, or 28 percent of production, was exported. Exports are expected to decrease as more coal is targeted for domestic consumption.

Coal-fired capacity in power plants is expected to increase between 1977 and 2000. Hard coal capacity in 1980 was approximately 30,000 mega watts of electricity (MWe), or 121 million metric tons, up 15 percent from that in 1977. It is expected to increase to 47,000 to 49,000 MWe by the year 2000. Lignite capacity is expected to rise to 18,000 MWe in 2000 (or 139 million metric tons), from 14,000 MWe (or 105 million metric tons) in 1977. The sector consumed 115 million metric tons in 1980. Penetration of the power-generating industry has been aided by "The Agreement of the Century." 1/

An increase in the production of synthetic fuels from conversion of coal is expected to fuel an increase in the consumption of coal into the year 2000. Fourteen gasification and liquefaction plants are being funded under a Government-supported plan, one of which could consume 12 million metric tons of hard coal per year and 10 million metric tons of lignite per year. Imports could account for as much as 5 million metric tons per year under the amended import regulations of 1980. Given the economic difficulties in 1981 and 1982, if the expected expenditures are restricted, the level of consumption would be lowered. 2/

Industry Structure

The West German coal industry is privately owned, with three firms dominating production. One company produced 75 percent of domestic hard coal in 1977, and another company accounted for 11 percent. One produced 88 percent of domestic lignite in 1977.

One company dominates the coal sector in world trading and overseas interests. 3/ Its subsidiary handles 10 percent of world coal trade, selling

---

1/ Peter James, op. cit., p. 194.

2/ Ibid., p. 195.

3/ Peter James, op. cit., p. 193; Robert Greene and J. Michael Gallagher, op. cit., p. 162.

coal to 39 companies. This company also has a holding in a new Rotterdam coal port to facilitate handling of the coal from its overseas interests.

West Germany is in the forefront of coal conversion technology. Three of the major coal-gasification technologies, Lurgi, Koppers-Totszek, and Winkler, were developed by and owned by West German companies. These firms are also developing second-generation versions of these technologies. The major coal liquefaction process that has remained in large-scale use, the Fischer-Tropsch process, was also developed by German scientists. Plans are underway to bring 14 gasification and liquefaction plants onstream, with the first expected to be in operation by the mid-1980's.

Members of the International Energy Agency, including West Germany, are involved in several joint venture coal conversion projects. These projects cover all areas of technology ranging from oil sands and natural gas pipelines, to coal gasification and liquefaction. West Germany's major partner in several of these projects is the United States. One of the liquefaction ventures includes West Germany, the United States, and Japan.

Trade

In an effort to guarantee the sale of West German coal, import limitations were imposed in 1959. The import quota system restricted importers to 5.1 million tons annually. The quotas were in effect until January 1, 1981, when the import laws were amended considerably. Imports of coal are also expected to be used increasingly in the production of coke to be exported. Total imports of coal to West Germany are expected to increase from 60 million to 136 million tons annually by 2000 from 30 million tons in 1977. 1/

West Germany's major sources of imports are the United States, South Africa, Australia, and Poland. During 1980-82, the United States increased shipments to West Germany; Poland's market share decreased in 1981 because of labor problems and then increased in 1982.

West Germany accounts for an average of 77 percent of total EC exports of coal. West German exports in 1977 amounted to approximately 20.2 million metric tons, or 22 percent of total production, compared with approximately 17.1 million metric tons in 1981. In 1981, approximately 42 percent of West Germany's total coal exports were coke.

Major markets for West Germany's exports are the other EC members--primarily France, Belgium, Italy, and the Netherlands. The U.S. market receives less than 1 percent of these exports.

United Kingdom

Reserves

Coal reserves in the United Kingdom presently total about 190 billion tons. This estimate could increase if economics and new technology permit the

---

1/ Ibid., p. 195.

mining of coal in seams deeper than 1,200 meters or under the North Sea. Some 45 billion metric tons, or 24 percent, of these reserves are economically and technically recoverable. The United Kingdom has about 15 percent of OECD recoverable reserves, or about 7 percent of the world's total recoverable reserves.

Operating reserves, or the reserves that have been proven to warrant new mines or are within reach of existing mines, stand at about 7 billion metric tons. These reserves are expected to increase by an additional 4 million metric tons per year during 1985-2000, under Plan 2000, developed by the National Coal Board (NCB).

Production

The NCB, which is responsible for the production of coal in the United Kingdom, was created in 1947 and is wholly Government owned. It is the largest producer of coal in the Western World and, in 1978-79, employed 233,000 workers.

NCB's production of coal has followed a downward trend from 223.6 million metric tons in 1957 to 124.4 million metric tons in 1979, as shown in the following tabulation (in millions of metric tons): 1/

1950	219.6	1975-1976	125.8
1955	225.2	1976-1977	120.8
1960	196.7	1977-1978	120.9
1965-1966	185.7	1978-1979	119.9
1970-1971	144.7	1979-1980 1/	125.7
		1980-1981 1/	126.6

1/ James Peter, The Future of Coal, MacMillan Press Ltd., pp. 178-180.

The decline in the 1960's and early 1970's was mainly due to a slowdown in demand resulting from the increased domestic consumption of crude petroleum and strikes in the winters of 1971 and 1972. This led to lowered capacities and less capital investment. After 1973, when energy demand hit a high, the increasing use of natural gas, the worsening economic conditions, and the recession in the steel industry all contributed to lowered demand, resulting in decreased production. 2/ Another strike, in 1974, reduced production by 15 percent to 106.7 million tons from the previous year.

Production increased in 1980 to 127 million metric tons due to large capital investments and advances in mining technology. The expenditures and improved equipment were implemented under the "Plan for Coal." Production tapered off, however, in 1981, to 124 million metric tons as consumption slowed due to the economic slowdown and the high value of sterling in that year.

1/ Robert Greene and J. Michael Callagher, op. cit., p. 393, except as noted.
2/ Ibid., p. 373.

The Plan for Coal, instituted after the crude petroleum crisis in 1973-74, called for more extensive exploration, investment, and research and development in an effort to develop increased capacity and productivity. 1/ The Plan for Coal, agreed upon by the NCB, the Government, and the coal-mining industry unions, was originally expected to cover the period to 1985, but has been expanded until the year 2000 because of longer lead times and the completion of some of the projects.

Most of the production of coal in the United Kingdom is from deep mines. Open-cast mines account for 10 percent of annual national output. Major coal fields in the United Kingdom include Yorkshire-East Midlands, Northumberland-Durham, South Wales, the Scottish fields, and fields in Lancastershire, Kent, South Derbyshire-Lancastershire, North-Central Stafford, and Warwickshire.

The Yorkshire-East Midlands field, the Staffordshire field, and the Warwickshire field, which are all located in central Great Britain, have been producing an increasing percentage of the coal mined in this century. The Yorkshire-East Midlands field produced 59.6 million metric tons of coal in 1979-80, or over one-half of domestic deep-mined output. The central fields have maintained their output due to the type of coal produced (low-medium bituminous) and accessibility to markets.

Fields in "peripheral" areas, such as South Wales, Northumberland-Durham, and the Scottish fields, have experienced decreasing output since the 1960's. Much of the decline is due to extensive working of the fields over many centuries, which has caused adverse geological conditions and exhaustion of the reserves, and to the decline in the steel industry and increased imports of coking coal. 2/ Output per man-shift in South Wales in 1979-80 was 1.39 metric tons, with a production cost of $89 per metric ton compared with the national average of 2.27 metric tons at $60 per metric ton. 3/ The decline in output is expected to increase in the future. Most new investment and new mines are concentrated in the central areas. Two new mines, Selby and Belvoir, are located in the eastern portion of the Yorkshire-East Midlands field and are expected to open in the mid-to-late 1980's. Production in the Yorkshire-East Midlands has steadily been moving towards the eastern section as the western section nears exhaustion. The reserves being mined in this field extend under the North Sea to continental Europe. 4/

Productivity in the mines increased during 1960-75. Some of the factors responsible for the increase include increased capital investment in the 1950's, the closure of several mines, and the mechanization of the mining process. Productivity continued to climb into the early 1980's despite the lack of capital investment in the 1960's. The continued increase has been attributed to new equipment and the improved performance of existing equipment implemented under the Plan for Coal. Productivity in mines utilizing the new and modified equipment in 1979-80 reached 1,628 tons per day compared with 672

1/ Ibid., pp. 369-70.
2/ Peter James, op. cit., p. 181.
3/ Ibid.
4/ Ibid., p. 179.

tons per day from mines employing conventional equipment. Automation and the increased efficiency of new mines are expected to cause a significant increase in productivity towards the end of this century. 1/

Importance to the Economy

Coal is expected to gain an increasing share of the primary energy market in the United Kingdom, as efforts are made to conserve domestic supplies of crude petroleum and natural gas, which, considering present usage and production, are projected to decline in the mid-1990's. 2/ The use of coal as an alternative source of energy would both extend reserves of crude petroleum and natural gas and reduce imports of these products. As of 1977, the utilities agreed to purchase a specified amount of domestic coal per year. This market, which is expected to consume about 75 million to 80 million metric tons in 1985, should exist as long as the market price of coal remains competitive with that of crude petroleum, and electricity demand continues to grow. 3/

The Government and the utilities are also looking toward nuclear energy as a future source of energy. The Central Electricity Generating Board (CEGB) maintained that it is less expensive to produce electricity from nuclear energy than from other energy sources, including coal. 4/ Thus, although coal is presently competing mainly with crude petroleum in the United Kingdom, future competition will more than likely be against nuclear energy as well.

Until 1971, coal was consumed in larger quantities than crude petroleum in the United Kingdom. Crude petroleum's share of the domestic market continued to increase until the 1973-74 embargo, when consumption of all energy, except natural gas, leveled off, because of the economic slowdowns, energy conservation, and the decline in the United Kingdom steel industry. Natural gas consumption increased, however, since all of the gas produced in the North Sea was consumed in the United Kingdom, allowing it to be priced independently from that of the world supply.

Crude petroleum is still imported to optimize both usage of the high-quality crude petroleum from the North Sea and usage in the refineries. 5/ In 1979, for example, 50 percent of the crude petroleum consumed and 11 percent of the natural gas consumed were imported.

Consumption

Consumption of coal in the United Kingdom declined in 1981 to approximately 111 million metric tons from about 116 million metric tons in 1980. The decline was attributed to the sluggish economy and the high value

---

1/ Ibid., p. 183.
2/ Robert Greene and J. Michael Gallagher, op. cit., p. 372.
3/ Peter James, op. cit., p. 186.
4/ Ibid.
5/ Robert Greene and J. Michael Gallagher, op. cit., p. 373.

of sterling. Production increased to 126.6 million metric tons in 1981 compared with 125.7 million metric tons in 1979. The inverse correlation between production and consumption during 1979-81 led to the formation of domestic stockpiles. 1/

The electrity-generating sector was the major domestic consumer of coal in 1981 and is expected to be the principal market for domestic coal until the end of the 1990's. As such, this sector, which consumed 87.8 million metric tons of coal in 1981, is encouraged by the Government to purchase domestic coal. 2/ The CEGB, the main utility in the United Kingdom, agreed to burn 75 million metric tons of coal per year; however, the agreement was modified to increase the coal burn by 2.5 million metric tons per year and to decrease CEGB's use of imported coal by 1.75 million metric tons per year. In 1980, CEGB burned 4.5 million metric tons of imported coal.

The next largest market for coal and the one expected to show the most growth in the future is the industrial sector. Domestic industry consumed 7.4 million metric tons of coal in 1981 compared with 8.9 million metric tons in 1980. New technology, such as fluidized-bed combustion, is expected to increase industrial consumption of coal. 3/

The consumption of coal in coke ovens declined from 14.3 million metric tons in 1980 to 11.3 million metric tons in 1981. This is in keeping with the downward trend followed since 1960, when consumption in this sector peaked at 29 million metric tons. The United Kingdom's steel industry, traditionally the major consumer of coking coal, has declined in recent years, forcing a cutback in capacity. The future markets for coking coal in the United Kingdom depend on improved efficiency in steel making, which would result in an increased demand for coke and an increased demand for electric-arc production. This market is not expected to grow significantly in the near future. 4/

Consumption in the domestic and commercial market declined from 10.3 million metric tons in 1980 to 8.5 million metric tons in 1981. The decline was due to several factors, including the development of smokeless zones, the growth in the natural gas network, and the increased use of central heating. Future growth in this market depends on the price and availability of natural gas and the amount of insulation required in housing. 5/

The production of synthetic fuels is viewed as an emerging market that will generate a significant increase in the domestic consumption of coal, although not until the next century. Several projects are presently underway, but, in general, growth is slow due to the present cost advantage crude petroleum has over coal, which is an impediment to the development of new coal utilization techniques.

1/ Robert Greene and J. Michael Gallagher, op. cit., p. 179.

2/ Ibid., p. 185.

3/ Future Coal Prospects, p. 385.

4/ Ibid.

5/ Ibid., p. 390.

Industry Structure

The NCB, which was established in 1949 to overcome friction between mine workers and mine owners, is responsible for the development of the coal mining industry in the United Kingdom. The Coal Plan has resulted in higher output and the upgrading of operating reserves, basically through increased capital investment in the 1970's. Rising costs of the investment program, however, have placed the NCB in a precarious financial position.

In 1980, the Government passed the Coal Industry Act, which helped ease some of the debts and established grants and incentives. In 1981, the NCB called for mine closures and a reduction in the workforce, mainly because of reduced sales, an economic slowdown, and the NCB's financial situation. Pressured by the union, the Government agreed to a plan that gave financial assistance to the NCB and imposed import restrictions. Although currently stablized, the NCB's financial difficulties are expected to eventually cause problems when coupled with the Board's plans for optimizing output. 1/

The Government has also encouraged domestic consumption of coal through grants and other incentives to individual industries. In 1979, the CEGB agreed to increase the amount of coal burned each year by 2.5 million metric tons and to reduce the amount of coal imported by the CEGB each year. 2/

The research program in coal technology in the United Kingdom is considered to be one of the largest such programs in the world. 3/ Two main areas of research are coal production and coal utilization. The Mining Research and Development Establishment (MRDE) carries out most of the work on increasing output, and the Coal Research Establishment (CRE) concentrates on coal conversion and combustion technology. 4/

Examples of the studies being carried out by MRDE include the development of remotely controlled equipment for mining and improving the efficiency of mining techniques. The latter range from decreasing the length of time needed to transport workers to the face to improved coal-handling systems. Developments in the area of remote control or automation include the Mine Operating System (MINOS) and face-monitoring systems. MINOS allows for semiautomatic working of the mines by controlling underground conveyors and bunkers. 5/

The development of fluidized-bed technology and the production of synthetic fuels are two examples of ongoing research programs at the CRE. Fluidized-bed combustion is the process in which coal is burned in "fluidized" inert ash and limestone, generating heat for industrial applications. Jets of air, introduced at the base of boiler, hold the ash and limestone in

---

1/ James, Peter, The Future of Coal, p. 185.
2/ Ibid.
3/ Ibid., p. 182.
4/ Robert Greene and J. Michael Gallagher, op. cit., pp. 416.
5/ Ibid., pp. 416-419.

suspension. As of 1982, about 50 atmospheric fluidized-bed boiler systems were either in operation or in the planning and/or construction stage. 1/

The production of synthetic fuels from coal is expected to become commercially viable towards the end of this century, in time to supplement the dwindling reserves of natural gas in the North Sea. The long lead time is attributed to several factors, including the present cost advantage crude petroleum has compared with coal, further technological developments, and budget restrictions imposed during downturns in the United Kingdom's economy.

The British Gas Corporation was one of the first utilities to start construction on a commercial gasifier and an advanced experimental plant to produce synthetic natural gas. 2/ Research is also being conducted in coal liquefaction. Conversion techniques that have been looked into include the supercritical gas extraction process that "skims" lower molecular weight components from the coal reaction mixture. The remainder is used for fuel or coal conversion. 3/

There is currently no major foreign investment in the United Kingdom's coal industry. An earlier coal gasification project involved an American petroleum company that supplied various American coals for testing.

Trade

During 1975-79, the United Kingdom was neither a major net exporter nor a major net importer. As shown in the following tabulation, imports declined from 4.8 million metric tons in 1976 to 2.1 million metric tons in 1979, and exports increased slightly from 1.4 million metric tons in 1976 to 2.1 million metric tons in 1979 (in millions of metric tons): 4/

Year	Imports	Exports
1976	4.8	1.4
1977	2.4	1.4
1978	2.7	1.8
1979	2.1	2.1
1980 1/	4.5	2.5
1981 1/	7.3	4.7

1/ United Kingdom Department of Trade, Overseas Trade Statistics of the United Kingdom, 1979-81.

The decline in imports during this period reflected both the worsening economic conditions in the United Kingdom and the relative lack of growth in

---

1/ OECD/IEA, Energy Policies and Programs of IEA Countries, 1982 Review, 1983, p. 373.
2/ Ibid.
3/ Ibid., p. 391.
4/ Ibid., p. 393.

overall energy consumption in those years. Imports nearly doubled between 1979 and 1980, mainly because of increased consumption by utilities. In 1981, the Government introduced restrictions on imports to avoid reductions in domestic coal capacity and the coal work force. These restrictions and the downturn in the economy kept imports at about 4 million metric tons in 1981 and 1982. Imports are expected to remain suppressed into the mid-1980's. Most of the coal imported is coking coal, followed closely by steam coal.

The United Kingdom's major sources of imports of coal are Australia, the United States, and Poland. Imports from these countries in 1983 accounted for approximately 45, 24, and 12 percent, respectively, of total coal imports. West Germany was the major source of imports from the EC in 1983, accounting for about 11 percent.

Exports increased slightly during 1979-81 by approximately 88 percent. This increase corresponded with the increase in domestic production of coal and the effort by the United Kingdom to increase its markets for coal in the 1980's. Exports are projected to increase in spite of the increasing number of less expensive imports from non-European sources. Most of the coal exported from the United Kingdom is steam coal.

Much of the coal exported from the United Kingdom was purchased by members of the EC. Major markets in 1983 included Denmark, France, and Finland, accounting for 25 percent, 25 percent, and 12 percent, respectively. 1/

The Republic of South Africa

Reserves

The Republic of South Africa has coal reserves estimated at 115.5 billion metric tons of which 113.3 billion metric tons, are bituminous deposits and 1.8 billion metric tons are anthracite deposits. 2/ South Africa's economically recoverable coal reserves are estimated at 58.4 billion metric tons and are divided as follows (in billions of metric tons): 3/

Low-to-medium grade bituminous	42.5
High grade bituminous	15.1
Anthracite	0.7
Other	0.1

The Karoo Basin is the largest coal basin in South Africa. Deposits are mainly medium-quality bituminous coal, with a low sulfur content of about 0.5 to 1.5 percent. 4/ The coal is located in thick seams at shallow depths. Volcanic activity in Natal has created narrow anthracite seams. The North Orange Free State contains deposits of low to medium grades of bituminous

---

1/ United Kingdom Department of Energy, Energy Trends, 1983.

2/ Peter James, The Future of Coal, 1982, p. 167.

3/ U.S. Department of State, Airgram, "Coal in South Africa," No. A-07, Mar. 9, 1984.

4/ Ibid.

coal. Other fields are known to exist in Central and Northern Transvaal, Eastern Natal, and Eastern Cape Province; however, there has been little exploration in these areas to date.

Production

South Africa has steadily increased its coal production from 38 million metric tons in 1960 to 140 million metric tons in 1982, as shown in the following tabulation (in millions of metric tons): 1/

Year	Production
1960	38.2
1965	48.4
1970	53.0
1975	70.0
1978	90.0
1979	103.0
1980	110.0
1981	114.0
1982	140.0

More than 50 percent of the coal produced comes from the Karoo Basin fields and about 20 percent from the North Orange Free State. 2/

About 84 percent of the total production was from underground mines in 1978; however, the opening of several surface mines reduced this percentage to about 65 to 70 percent in 1982. 3/ Coal is extracted from the mines using conventional technology.

Importance to the Economy

South Africa depends on coal to provide almost 75 percent of its energy needs. 4/ The coal industry employed 120,000 workers in 1977. 5/ Since the 1950's, the Government has maintained price and export controls on coal, which have resulted in lower domestic coal prices compared with the world price. 6/ In 1976, price controls were eased; however, 1979 bituminous coal export prices were almost 3 times higher than domestic prices. 7/ As a result, capital has been difficult to attract, investment in new equipment has been low, and only the most profitable seams have been developed.

In 1983, South Africa's Federated Chamber of Industries (FCI) asked the country's Department of Mineral and Energy Affairs to investigate pricing

---

1/ U.S. Department of State, op. cit, p. 20, and industry sources.
2/ Peter James, op. cit., pp. 168-169.
3/ Ibid., pp. 169-170.
4/ Ibid., p. 172.
5/ Ibid., pp. 169-170.
6/ Ibid.
7/ Ibid.

policies for South Africa's coal sold on the local market to allow domestic coal prices to rise to levels that will encourage investment in new mines. 1/ In addition, the FCI argues that there is a need to maintain the overall competitiveness of the energy-intensive sectors of the economy, especially those producing primarily for the export market. According to industry sources, the primary reason for the FCI's request was the significant difference between the market-related international coal price and the controlled (internal) South African price for coal. 2/

Other local sources maintain that a major price increase for coal sold on the local market will probably become essential over the near term, unless the "low" increases allowed under the controlled price system are made more realistic. These sources maintain that, over the past 8 years, coal prices have consistently failed to keep up with inflation rates. They also believe that although low energy prices do contribute to the economic growth rate of the country, the current price is far below the level required to justify new capital expenditures, which would then maintain (or even increase) the coal sector's supply capacity. Although continuing small increases in the controlled price will have short term benefits for the economy as a whole, these observers argue that, ultimately, they will lead to a point at which a major upward adjustment will be required, as serious supply shortages develop; this development will negate the short term benefits gained by the Government-mandated price increases made earlier. 3/

Consumption

Most of the coal produced in South Africa (about 40 percent) is consumed in the generation of electricity. Most of the electricity is generated at minemouth power stations of the Electricity Supply Commission.

South Africa converts large quantities of coal into liquid and chemical products. Most of these coal products are used as feedstock in the production of polyvinyl chloride and methanol. 4/

Coke ovens used in steel production consume about 10 percent of the coal production. Other consumers include those railroads still using coal-burning locomotives. Approximately 25 percent of the coal produced is steam coal exported to the EC.

Industry Structure

The Department of Mines is responsible for coal exploration and production. The South African Government holds 10 billion tons of recoverable reserves under provisions of the Reserve Mineral Development Act. 5/

1/ U.S. Department of State, op.cit., p. 17.

2/ The domestic price of coal is restricted to levels less than the country's average inflation rate.

3/ U.S. Department of State, op. cit., p. 17.

4/ Ibid.

5/ U.S. Department of State, op. cit., p. 20.

Coal-producing interests are represented by the South African Chamber of Mines, which has some management functions, including wage and condition negotiations. As with other South African minerals, coal output is controlled by five large mining finance houses, two of which controlled 67 percent of total coal sales in 1978. Another large producer's mines provide coal for its coal conversion plants. However, several foreign companies have been investing in coal exploration and development and should become a major force by the end of the 1980's. 1/

South Africa utilizes conventional mining methods in the production of coal. There are also coal conversion plants in operation.

The Government of South Africa allows foreign investment in their coal industry. About 1.8 billion metric tons of coal reserves are held by private concerns, one of which is a foreign petroleum company.

Trade

South Africa imports little or no coal. The nation relies on domestic production to satisfy demand.

Export coal accounts for about 25 percent of total coal production. Most of the export coal is steam coal shipped to the EC. Japan is another major market for South African export coal. South Africa's coal exports are shown in the following tabulation (in millions of metric tons): 2/

Year	Metallurgical coal	Steam coal	Total
1979	2.0	21.4	23.4
1980	2.0	24.0	26.0
1981	2.0	24.5	26.5
1982	2.0	24.9	26.9
1983	3.2	23.9	27.1
1984 1/	3.3-3.6	24.0-27.0	27.3-30.6

1/ Estimated.

Japanese steel mills are reported to have promised an increase in their South African coking coal purchases in 1984 in exchange for a 6.7 percent drop in the price of coal. According to Transvaal Coal Owners' Association (TCOA) sources, the Japanese Ministry of International Trade has predicted a 22 percent growth in imports of coal into that country from April 1, 1984, as a direct result of this agreement. The 6.7 percent price decline agreed upon at the end of last year represents a fall of $3 from the official 1983 price level, from $44.50 to $41.50 per metric ton f.o.b. 3/

1/ Peter James, op. cit., p. 169.

2/ Chase Manhattan Bank, The Coal Situation, Vol. 1, No. 3, March 1981, p. 3 and Vol. 4, No. 2, March 1984, p. 3.

3/ U.S. Department of State, op. cit., p. 17.

The growth of South Africa's coal exports through Richards Bay over the past few years has necessitated a complete upgrading of the railway line between Piet Retief (in the southeastern Transvaal) and the Natal coast. The rail line was originally designed to carry 21 million metric tons per year. However, now that the country's overall coal export quota has been raised to 44 million metric tons per year (by 1987), with an ultimate target of 84 million metric tons (by 1992), the line's capacity is generally considered to be inadequate. As a result, South Africa's largest tracklaying contract was recently awarded for improvements to the line. Work on the 3-year contract began in September 1983. Based on present plans, the export capacity of the Richards Bay line, which is likely to be the critical infrastructural link in the drive to build up coal exports, could increase as follows (in millions of metric tons per year): 1/

Year	Capacity
1984	37.0
1985	40.0
1986	42.0
1987	44.0

U.S.S.R.

Reserves

The U.S.S.R., has about 24 percent of the world's known coal reserves. The U.S.S.R.'s vast coal reserves are reported by one source to include about 233 billion metric tons of recoverable coal reserves; 87 billion metric tons, or 37 percent of the total, are lignite. 2/ Another source reports that U.S.S.R. has 165 billion metric tons of recoverable coal reserves; another source reported that the U.S.S.R.'s coal reserves include about 80 billion

---

1/ Ibid., p. 3.

2/ The U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1995, July 1984, p. 5, "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 1981, p. 79; "Oil and Gas; Soviet Energy Management," Industrial Development, November/December 1983, p. 26; Peter James, op. cit., pp. 11 and 125; and, Carroll L. Wilson, Coal-Bridge to the Future: Report to the World Coal Study, Cambridge, MA, 1980, p. 161. This last source, p. XXII, reports that a ton of coal equivalent is a metric ton of coal with a specific heating value (12,000 Btu's per pound). Since the heat content of coal varies significantly, more than one metric ton of coal is frequently required; Charles Simeons, Coal: Its Role in Tomorrow's Technology, 1978, p. 22, reports proved and possible reserves of coal at 420 billion metric tons.

metric tons of hard coal and an additional 9 billion metric tons of lignite. 1/ Still another source reports that the U.S.S.R. has proven, probable, and some possible reserves of 275 billion tons, or 384 years worth of coal at 1981 production levels. 2/ Siberia now accounts for 90 percent of the U.S.S.R.'s coal reserves, with about 75 percent of these reserves concentrated in the eastern or Asian portion of Siberia. 3/

There are seven major coal fields in the U.S.S.R. They are Donetsk, Pechora, Moscow, Kuznetsk, Karaganda, Ekibastuz, and Kansk-Achinsk. 4/ The most important of these basins are Donetsk and Kuznetsk, which both utilize underground mining, and Kansk-Achinsk, which utilizes open-pit mining. In the aggregate, these three basins account for 87 percent of the U.S.S.R.'s explored coal reserves.

Of these three, only the Donetsk coal field, is located in the populated, industrialized area of the U.S.S.R, near the Black Sea in the Ukraine. The winters in the Ukraine, though hard, are not comparable in severity with winters in other coal-rich, but remote, regions of the Soviet Union, such as Siberia. For example, temperatures at Kuznetsk maintain levels of minus 40 to minus 50 degrees Fahrenheit for extended periods during winter. Equipment failure, such as frozen conveyor belts, is not uncommon under such harsh conditions.

The economically accessible coal reserves in the western portion of the U.S.S.R. are on the decline as the reserves move to greater depths. For example, mining in the Donetsk coal fields, which accounts for about 27 percent of total coal production in the U.S.S.R., now takes place along thin seams, 27.6 to 47.2 inches thick and at depths of about 3,281 feet. 5/ By

---

1/ "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 1981, p. 79; "Oil and Gas; Soviet Energy Management," Industrial Development, November/December 1983, p. 26; Peter James, op. cit., pp. 11 and 125; and, Carroll L. Wilson, Coal-Bridge to the Future: Report to the World Coal Study, Cambridge, MA, 1980, p. 161. This last source, p. XXII, reports that a ton of coal equivalent, is a metric ton of coal with a specific heating value (12,000 BTU's per pound). Since the heat content of coal varies significantly, more than 1 metric ton of coal is frequently required. The U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1995, July 1984, p. 5, reports that the Soviet Union has 233 billion metric tons of recoverable coal reserves. Lignite recoverable reserves amount to 87 billion metric tons, or more than 37 percent of the total.

2/ Ed A. Hewitt, Energy Economics, and Foreign Policy in the Soviet Union, The Brookings Institution, Washington, DC, 1984, p. 27.

3/ Industrial Development, November/December 1983, pp. 12 and 31.

4/ Peter James, op. cit., pp. 125-153; "How White was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "Ambitious Siberian Project Encounters Difficulties," World Coal, June 1983, pp. 13 and 14; and, "Soviets Sit on Frozen Assets in Cold Coal Fields of Siberia." Coal Age, May 1983, p. 12.

5/ "Labour Aristocracy," The Economist, Sept. 19, 1981, pp.78 and 83; and, "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74.

1990, most of the coal seams at Donetsk are expected to be at depths of 3,937 to 5,249 feet; temperatures at these depths reach levels of 110 to 120 degrees Fahrenheit.

Production

Coal production in the U.S.S.R. peaked in 1978 at 724 million metric tons in 1978, and declined to 719 million metric tons in 1979, 716 million metric tons in 1980, and 704 million metric tons in 1981 (the 1981 production target was 738 million metric tons of coal). 1/ Some industry sources believe that the reported coal production data during 1978-81 may be overstated by as much as 30 percent. 2/ The 1983 coal production quota of 723 million metric tons was not met, as only 716 million metric tons were produced, down from 718 million tons in 1982. 3/ Coal production declined still further in 1984 to 714.7 million metric tons, but was projected by a Soviet official to reach 726.2 million metric tons in 1985. 4/

One reason for the recent decline in coal production in the U.S.S.R. is that planned development of large strip mines in the east has not kept pace with the decline in deep-mined coal production in the west, especially at the Donetsk coal field in the Ukraine. 5/ This has been due in part to a failure on the part of the domestic industry to furnish enough modern equipment to the coal industry, plus manpower shortages and inadequate infrastructure (e.g., poor and inadequate housing). 6/ Another reason cited for the decline of coal production in the U.S.S.R. is a decline in the quality of coal in existing coal fields. 7/ The ash and sulfur content of coal at some of the major coal basins, such as Donetsk, is reported to be rising, but the caloric value is declining.

1/ John Paxton, The Statesman's Year-Book: 1982-1983, New York, 119th ed., 1982 p. 1229; "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; and, Peter James, op. cit., pp. 125-153.

The U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1995, July 1984, p. 7, reports coal production in the Soviet Union for 1982 at about 717.6 million metric tons.

2/ Ibid.

3/ U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States; U.S.S.R., FET 84-91, September 1984, p. 2.

4/ N.K. Bazbakov, Chairman of the U.S.S.R. Gosplan, report to the Supreme Soviet entitled, "On the State Plan for the Economic and Social Development of the U.S.S.R. for 1985 and the fulfillment of the Plan in 1984," FBIS Daily Edition, Soviet Union, Nov. 28, 1984, p. 7.

5/ John Paxton, The Statesman's Year-Book: 1982-1984, New York, 119th ed., 1982 p. 1229; "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; and Peter James, op. cit., pp. 125-153.

The U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1995, July 1986, p. 7, reports coal production in the Soviet Union for 1982 at about 717.6 million metric tons.

6/ "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83; and, "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74.

7/ Peter James, op. cit., pp. 125-153.

In 1981, the U.S.S.R. obtained about 38 percent of its coal from open-pit mines located mainly in the east. By 1985, the U.S.S.R. expects to obtain about 42 percent of its annual coal production from open-pit mines. The U.S.S.R. reportedly has calculated that open-pit mines are four and one-half times less expensive and nine times more productive than underground mines. 1/

Importance to the Economy

In 1940, coal furnished 75 percent of the U.S.S.R.'s energy needs; by the late 1970's, coal's share of the U.S.S.R.'s energy needs had declined to 29 percent. The U.S.S.R. expects coal to supply about 50 percent of the electricity generated by the end of the 1980's compared with about 37 percent in 1980. 2/ The U.S.S.R. has also planned for coal's share of domestic annual fuel consumption to rise from a level of 25 percent in 1980-81 to a level of about 30 percent in 1985. This increased share will be attained as the nation switches from petroleum to coal in its power stations. 2/

Economics is an important reason for the substitution of coal for petroleum for domestic energy needs. 3/ Crude petroleum has been the U.S.S.R.'s principal source of hard currency (60 percent of the total in 1980) needed to purchase Western grain, technology, and equipment.

Consumption

Most of the U.S.S.R.'s coal production is used internally; annual domestic consumption accounts for about 95 percent or more of production. 4/ Some industry sources believe that the U.S.S.R's domestic consumption of coal could continue at this rate of production, and one source reports that the U.S.S.R. does not plan to become a major world supplier of coal in the near future.

Most coal in the U.S.S.R., as in the United States, is consumed in the generation of electricity. More than 50 percent of all coal mined goes into coal-fired power stations. Coke, both as a feedstock for chemicals and for the steel industry, is the other leading market for coal. In recent years, coke production has annually represented about 25 percent of the total coal output. 5/

1/ "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83.

2/ "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83; "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; and, Peter James, op. cit., pp. 125-153.

3/ U.S. Deparment of State, Background Notes: U.S.S.R, September 1981, pp. 8-10; and, "Oil Prices are Socking It To the Soviet Bloc," Business Week, May 30, 1983, p. 101.

4/ Peter James, op. cit., pp.125-153; and "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 1981, p. 79.

5/ Ibid.

The U.S.S.R. is looking toward domestic and industrial applications as an outlet for Siberia coal in liquefied or gasified form. This would eliminate the problem of having to transport Siberia's coal as a solid fuel over several thousand miles. It is believed that the large-scale production of synthetic petroleum from Siberian coal would not take place until the 1990's. 1/

To further alleviate the problem of transporting coal, especially lignite, from the east, the U.S.S.R. plans to build coking plants and other industrial plants near the deposits in the East. 2/ The U.S.S.R. also plans to erect electrical power-generating stations in the vicinity of the open-cast mines and then transmit the electricity to Western industrial cities over high-voltage cables; however, technical problems (i.e., loss of power) must be solved before long-distance, high-voltage transmission becomes practical. 3/

Industry Structure

The coal industry in the U.S.S.R. is State-owned and comes under the control of the Ministry of the Coal Industry. 4/ The coal industry's structure was simplified in the 1970's when autonomous regional corporations were formed. These corporations report either directly to the Minister or, in the Ukraine, indirectly by way of Republican Coal Ministers.

Coal, like all other energy resources in the U.S.S.R., comes under the auspices of the States Five-Year Plan. The U.S.S.R. is presently in its 11th Five-Year Plan (1981-85). 5/ The Government attempts to relate the production of coal in the U.S.S.R. to the overall domestic energy needs.

Technology in the U.S.S.R.'s coal industry reportedly is not as current as in Western nations. This is due, in part, to the dominance of petroleum and natural gas as fuel sources in the nation in the 1960's and 1970's and, reportedly, in part to lack of coordination between the Ministry of the Coal Industry and those industries that effect the fortunes of coal, such as the Ministry of Po[illegible] Building. 6/

1/ "The Case for Synthetic Oil," Petroleum Economist, December 1982, p. 512.

2/ Peter James, op. cit., pp. 125-153; and, "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 1981, p. 79; and, Ed A. Hewitt, op.cit., pp. 83, 87, and 93-95.

3/ "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 1981, p. 79; Peter James, op. cit., pp. 125-153; Industrial Development, November December 1983, pp. 31 and 32; and "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83.

4/ Peter James, op. cit., pp.125-142 U.S. Department of States, Background Notes, September 1981, p. 8; and, Ed A. Hewitt, op.cit., pp. 42 and 43.

5/ "Siberian Development: An Overviewing," Industrial Development, November/December 1983, pp. 10 and 11.

6/ Industrial Development, November/December 1983, pp. 12, 30, 31, and 32; Peter James, op. cit., pp. 125-153; "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83; and, "Soviets Sit on Frozen Assets in Cold Coalfields of Siberia," Coal Age, May 1983, p. 27.

Manufacturers of coal mining equipment in the U.S.S.R. have not been given incentives to produce more modern equipment, as the coal industry has had a low priority through much of the 1970's. The U.S.S.R. instead uses coal mining equipment imported from Canada, Japan, the United States, and West Germany at many coal fields, such as the Neryungii mine at the Southern Yakunta Basin in Siberia. 1/

There is no foreign investment in the U.S.S.R.'s coal industry. However, the Government does encourage bartering with Western nations. Coal or coal derivatives are exchanged as partial or total payment for Western coal technology and/or Western capital. 2/ The U.S.S.R. prefers bartering to minimize the flow of hard currency to other nations.

Trade

Imports of coal are minimal, at 2 percent or less of annual consumption. Poland, the principal source of these imports, supplied the U.S.S.R. with about 9 million metric tons in 1982, about the same level as in 1979. 3/ The coal imports are shipped mainly to the industrialized western part of the U.S.S.R., because the coal mines in Poland are closer to the markets in that part of the U.S.S.R. than are the coal fields emerging in the U.S.S.R. above the Arctic Circle and in Siberia.

As stated earlier, crude petroleum has been the major source of hard western currency for the U.S.S.R. As a result of the natural gas pipeline from western Siberia to Western Europe, the U.S.S.R. apparently plans to substitute natural gas for petroleum as their leading hard currency earner, and crude petroleum production in the U.S.S.R. is projected to level off and then decline. 4/ Therefore, it is important for the U.S.S.R. to substitute coal on the home market, wherever possible, for these two hard-currency earners. 5/

Since coal is becoming more important to the U.S.S.R. as an internal energy source, some industry sources, as stated previously, believe that coal exports could remain at less than 5 percent of annual coal output or at 10 percent of annual world coal trade. 6/ However, another source believes that

---

1/ Ibid.

2/ "Ambitious Siberian Project Encounters Difficulties," World Coal, June 1983, pp. 13 and 14; "How White Was My Valley," The Economist, June 5, 1982, pp. 73 and 74; "Soviets Sit on Frozen Assets in Cold Coalfields of Siberia," Coal Age, May 1983, p. 27; "German Technology Teams Up With Soviet Coal," Business Week, Nov. 30, 198 p. 79; John Paxton, op. cit., pp. 1,216 and 1,231; and, Peter James, op. cit., p. 134.

3/ Peter James, op. cit., pp. 125-153.

4/ U.S. Department of State, Background Notes: U.S.S.R., September 1981, p. 10.

5/ "Oil Prices are Socking It To the Soviet Bloc," Business Week, May 30, 1983, p. 101 and 102; and, "Labour Aristocracy," The Economist, Sept. 19, 1981, pp. 78 and 83.

6/ Peter James, op. cit., pp. 138; and John Paxton, op. cit. p. 1229.

the U.S.S.R.'s coal exports could, in terms of hard coal equivalent, climb from 8 percent of world coal exports in 1980 to nearly 14 percent of world coal exports in 1990 and to about 17 percent of the total in 2000. 1/

Coal exports from the U.S.S.R. are reported by official sources as follows during 1978-82 (in millions of metric tons): 2/

Year	Quantity
1978	28.7
1979	25.8
1980	25.6
1981	22.0
1982	21.7

As shown in this tabulation, coal exports have decreased by more than 24 percent during this period. The future of U.S.S.R. coal exports is at best, projected to be stagnant through 1990. 3/

Except for Finland and Japan, which either receive or are scheduled to receive U.S.S.R. coal under bartering agreements, most coal goes to COMECON countries, mainly East Germany, Bulgaria, and Czechoslovakia, which pay for their coal principally through the exchange of goods with the U.S.S.R. Western nations, other than those involved in barter agreements, pay for the U.S.S.R.'s coal shipments with hard currency.

People's Republic of China

Reserves

China is estimated to have 540 billion metric tons of recoverable coal reserves, and ranks third after the United States and the Soviet Union in terms of reserves. 4/ Industry sources report that more than 80 percent of

---

1/ "U.N. Commission predicts Doubling of World Coal Demand by 2000," World Coal, August 1983, pp. 19 and 20.

2/ U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1995, July 1984, p. 2.

3/ Ed A. Hewitt, op. cit., pp. 179 and 180.

4/ "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14.; U.S. Department of State, Background Notes: China, December 1983; and, Peter James, op. cit., pp. 125-153. In the aggregate, China, the United States, and the U.S.S.R. represent about 56 percent of the world's technically and economically recoverable coal reserves. This was drawn from Carroll L. Wilson, Coal-Bridge to the Future: Report of the World Coal Study, (WOCOL), Cambridge, Mass, 1980, p. 161.

The U.S. Department of Energy, Annual Prospects for World Coal Trade, 1984: With Projections to 1995, July 1984, p. 5, reports that China has about 99 billion metric tons of recoverable coal reserves. A. Doak Barnett, China's Economy in Global Perspective, Washington, 1982, p. 417, reports that China's proved coal reserves are at least 80 billion metric tons and that a conservative Chinese estimate placed reserves at 600 billion metric tons in 1980.

China's coal reserves are bituminous coal and the remaining is lignite coal. Lignite has the effect of reducing the annual coal output in terms of thermal equivalency or heating value. 1/

China's major coal reserves, about 67 percent of its total, are located in the remote area of the Shanxi Province and in Inner Mongolia. China presently lacks sufficient rail equipment and loading facilities to become a major coal exporter and still meet expanding domestic demands. 2/

Production

Coal production in China amounted to about 715 million metric tons in 1983, a historical high, more than 7 percent above the 666 million metric tons of coal produced in 1982 and 15.3 percent more than the 620 million metric tons produced annually both in 1980 and 1981. 3/ The 1983 output of coal exceeded the 700 million metric tons projected for 1985 in China's Sixth Five-Year Plan (1981-1985). China's projected coal output for the year 2000 is 1,200 million metric tons. 4/ About 25 percent of China's total annual output of coal in recent years has come from the Shanxi province and Inner Mongolia. 5/ Between 1981-85, China plans to add 80 million metric tons of capacity to its coal production capability; part of this goal will be attained by starting up 28 large coal mines each with an annual capacity in excess of 1 million tons. 6/

In 1982, the large coal mines under the jurisdiction of the Ministry of Coal accounted for about 55 percent of the total output, about the same percentage as produced in 1978. The remaining 45 percent of annual coal output was from mines either controlled by local governments or run directly

---

1/ Ibid.

2/ Coal Mining and Processing, July 1983, pp 22 and 23; Peter James, op. cit., pp. 125-153; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; and, "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D.

3/ U.S. Department of State, Background Notes: China, December 1982, p. 8; "China Breaks Record," Coal Age, February 1983, p. 39; U.S. Department of Commerce, China's Economy and Foreign Trade 1981-85, September 1984, p. 2; U.S. Department of the Interior, Mineral Industries of China (Reprinted from Mining Annual Review 1984), p. 2; and U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States: China, FET 84-37, March 1984, p. 2.

4/ The Sixth Five-Year Plan of the People's Republic of China for National Economic and Social Development 1981-1985, Beijing, China, 1st ed., 1984, pp. 88 and 89; and U.S. Department of Commerce, China's Economy and Foreign Trade 1981-85, September 1984, pp. 18-20.

5/ Coal Mining & Processing, July 1983, pp. 22 and 23.

6/ The Sixth Five-Year Plan of the People's Republic of China for National Economic and Social Development 1981-1985, Beijing, China, 1st ed., 1984, pp. 88 and 89; and U.S. Department of Commerce, China's Economy and Foreign Trade 1981-85, September 1984, pp. 18-20.

BEST COPY AVAILABLE

by communes. 1/ More than 95 percent of China's coal now comes from underground mines, although five new open-pit mines are planned for Shanxi province.

Importance to the Economy

Coal supplied 90 percent of China's energy needs in the 1960's; by 1980-83, coal annually accounted for 70 percent of the output of all major types of primary energy in China and 75 percent of China' industrial fuel and power. (By comparison, in other developing countries, coal's share of total, annual commercial energy averages 14 percent.) 2/ Industry sources report that coal's share of total energy production in China should increase throughout the 1980's, since crude petroleum production has leveled off near 100 million metric tons per year in recent years and annual natural gas production has declined in recent years. 3/

Consumption

Consumption of coal in China is virtually equal to production. Imports of coal to China are negligible, since this is one energy source China has in abundance. Trade sources report that China's coal exports are small at present primarily because of infrastructure problems, particularly in inland transportation and port facilities. In the recent years, exports have totaled about 7 million metric tons per year and have represented only about 1 percent of China's annual coal production. 4/

In the early 1980's, the household market in China annually accounted for about 30 percent of that country's annual coal output. Other important markets for coal in China include coking applications, with 10 to 17 percent of the annual market share; electrical power generation, with an 18 percent annual market share; a 4 to 5 percent annual market share for railroads; and a 40 to 50 percent market share for other industries, such as chemical and general industrial use. 5/

1/ Peter James, op. cit., pp. 125-153; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; and, Carroll L. Wilson, Future Coal Prospects: Country and Regional Assessment, Cambridge, MA, 1980, pp. 99-102.

2/ "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; Coal Mining & Processing, July 1983, pp. 22 and 23; "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14; A World Bank County Study, China: Socialist Economic Development, Vol. I, August 1983, p. 125; U.S. Department of Commerce, China's Economy and Foreign Trade, 1981-85, September 1984, pp. 2 and 20; and, U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States: China, FET-84-37, March 1984, p. 2.

3/ Ibid.

4/ "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; Peter James, op. cit., pp. 125-153; and, U.S. Department of the Interior, Mineral Industries of China (Reprinted from Mining Annual Review 1984), p. 3.

5/ Ibid.

Industry sources believe that environmental problems could encourage greater emphasis on employing coal in the generation of electricity, especially mine-site power plants. Mine-site power plants have the advantage of efficiently utilizing coal without putting additional strain on China's transportation system. 1/

Industry Structure

China has both a Ten-Year Plan (1981-90) and its sixth Five-Year Plan (1981-85), which are the guidelines for China's economic development. The coal industry comes under these plans, which are prepared by the Ministry of Coal Industry in conjunction with the State Planning Commission. However, a large number of small mines (17,000 or more) are run directly by the communes and are outside the formal planning system. 2/ The Ministry of Geology and Minerals directs and coordinates exploration of coal (and other minerals) in order to determine the magnitude and location of these deposits. 3/

The major mines (about 550 in number) in China come under the authority of the Ministry of Coal Industry; however, related activities such as exports and infrastructure come under separate ministries. About 2,000 of the smaller coal mines are controlled by local governments, and 17,000 or more are cottage type coal mines run directly by the communes. These smaller mines serve a dual role. 4/ These mines are important to the economic well-being of rural communities, and help alleviate the strain on China's railroad system by permitting the coal to be consumed locally. These minimines are said to represent about 15 percent of China's annual coal output. 5/

1/ "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983. Other sources report that the residential market in China represents between 17 and 21 percent of total coal production; these sources are Peter James, op.cit., pp. 125-153; Carroll L. Wilson, Future Coal Prospects: Country and Regional Assessment, Cambridge, Mass., 1980, pp. 99-102; and, A World Bank Country Study, China: Socialist Economic Development, vol. I, August 1983, p. 195.

2/ Jan S. Prylyla, The Chinese Economy Problems and Policies, Columbia, S.C., 2nd ed. revised, 1981, pp. 102-179; U.S. Department of State Background Notes: China, December 1983, pp. 7-9; John Paxton, The Statesman's Year-Book: 1982-1983, N.Y. 1982, pp. 349-350; The Europa Yearbook 1982: A World Survey, vol. II, London, 1982, p. 10; and, Peter James, The Future of Coal, London, 1982, pp. 142-148.

3/ U.S. Department of the Interior, The Mineral Industry of China, (Preprint from the 1982 Bureau of Mines Minerals Yearbook), p. 14.

4/ The 550 major coal mines and the 2,000 or so coal mines controlled by local governments reportedly employ an aggregate of about 4.2 million people. This was drawn from the U.S. Department of Interior, Mineral Industries of China, (Reprinted from the Mining Annual Review 1984), p. 2.

5/ "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14; Carroll L. Wilson, Future Coal Prospects: Country and Regional Assessment, Cambridge, MA, 1980, pp. 99-102; Peter James, op.cit., pp. 125-153; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; and, A World Bank Study, China: Socialist Economic Development, Vol. I, August 1983, p. 126 and 127.

China's own coal technology and equipment reportedly are not as current as that in most Western nations. Since coal is China's primary energy source, the Chinese Government has committed its development priorities towards acquiring and absorbing advanced Western coal technology and equipment. 1/ Approximately 20 percent, or $9 billion, of China's capital funds committed to the current Five-Year Plan (1981-85) have been assigned to coal mine development. It is reported that $1 billion to $2 billion of the $9 billion will go towards purchasing foreign coal production equipment. 2/

Foreign investment is not only permitted by China in its coal industry, but actively sought as part of China's "open door" policy. 3/ China's Director of Foreign Investment Administration and Ministry of Foreign Economic Relations and Trade stated at the China Mines Investment and Marketing Seminar in Beijing during March 1983 that efforts should continue to encourage foreign loans. Direct foreign investment and joint Chinese-foreign ventures should be encouraged to increase the use of foreign funds in the development of China's coal industry, including necessary infrastructure and ancillary facilities and equipment. Under a 1979 law, there is no upper limit on the foreign firms share of the joint venture; however, the minimum share is 25 percent. 4/ China published a set of regulations on September 20, 1983, which helped to clarify some of the problems foreign firms have had with China's policy towards foreign investors. Foremost among these new regulations was an attempt by the Chinese Government to deal with issues critical to the profitability of joint ventures, such as the valuation of capital inputs. 5/ China now has, or is contemplating, cooperative joint venture contracts or feasible studies with engineering firms in such countries as France, Italy, West Germany, Spain, the United States, Japan, and the United Kingdom.

Trade

As a major producer, China imports very little coal, and these imports ranged from about 1.9 million metric tons in 1981 to about 2.1 million to 2.2

1/ Ibid.

2/ "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14; Carroll L. Wilson, Future Coal Prospects: Country and Regional Assessment, Cambridge, MA, 1980, pp. 99-102; Peter James, op.cit., pp. 125-153; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; and, "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D.

3/ U.S. Department of Commerce, China's Economy and Foreign Trade: 1981-85, September 1984, pp. 25-28.

4/ U.S. Department of State, Background Notes: China, December 1982, p. 9; The Europa Yearbook 1982: A World Survey, Vol. II, London, England, 1982, p. 110; John Paxton, op. cit., p. 352; ""China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; and, "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14.

5/ U.S. Department of Commerce, China's Economy and Foreign Trade: 1981-85, September 1984, pp. 26.

million metric tons annually in 1982 and 1983. 1/ Most of China's coal imports are high quality coking coal, since China still lacks adequate coal washing and blending facilities. China's major suppliers are Japan, the United States, Hong Kong, West Germany, and Canada.

China's coal exports, as stated previously, are also minimal, about 6 million to 7 million metric tons per year, or about 1 percent of annual production. The Chinese Government hopes to triple its coal exports by 1985. 2/ Another source estimates that China's coal exports could increase from less than 2 percent of world coal exports in 1980 to more than 4 percent of world coal trade total by the year 2000. 3/

The low level of exports for one of the world's leading coal producers is attributed by industry sources to several factors. 4/ First, the domestic demand for energy has increased in recent years as China has moved toward the modernization of its industrial base. It is more economical for China to export petroleum, which has a higher foreign currency value per unit of energy, and to save coal for domestic uses. Second, productivity is low since the coal-mining industry in China is generally behind world standards. For example, since most of China's labor force is not equipped or trained for modern mining, the coal mines in China are generally small, much of the underground production is not mechanized, and local technology for surface mining is only minimal at best. Third, China's railroad system, port facilities, and other critical infrastructure are in need of expansion to increase exports. 5/ Fourth, more coal preparation plants should be built to upgrade the quality of the coal. Finally, there is a need for improved coordination between the various Ministeries, (such as coal, communications, railroads, foreign trade, and equipment procurements). 6/

Non-Communist nations today account for 90 percent or better of China's total exports. 7/ The principal market for coal exports has been Japan, with lesser amounts to the Republic of Korea. China has signed coal contracts with

---

1/ U.S. Department of the Interior, Mineral Industries of China (Reprinted from Mining Annual Review 1984), p. 3.

2/ A World Bank Country Study, China: Socialist Economic Development, Vol. II, August 1983, p. 217.

3/ "U.N. Commission Predicts Doubling of World Coal Demand by 2000," World Coal, August 1983, pp. 19 and 20.

4/ "U.N. Commission Predicts Doubling of World Coal Demand by 2000," World Coal, August 1983, pp. 11, 19 and 20; "Chinese Exports, Coal Age, November 1982, p. 33; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14; and, Peter James, op. cit., pp. 125-153.

5/ Department of Energy, Coal-Exporting Countries: The Asian Market, December 1984, pp. 23 and 24. This source also cites shipment size, about 10,000 tons maximum, as another impediment to China's ability to increase its level of coal exports.

6/ "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; and, Peter James, op. cit., pp. 125-153.

7/ U.S. Department of State, Background Notes: China, December 1983.

Spain and the Republic of Korea and hopes to supply other Western European and Southeast Asian markets. 1/

Much of China's coal exports, such as those to Japan, are implemented through the use of bartering; that is, coal exports are used to repay capital investment both from foreign governments and from international financial institutions as well as for technology transfers. 2/ China recently (late 1982-early 1983) stated that payment for Western technology will not necessarily always be in coal. For example, China coal exports, paid for in hard currency, could be used to help pay for China's imports of Western plants, technology, and equipment that are not covered by barter agreements.

Poland

Reserves

Trade sources report that Poland has an estimated 120 billion metric tons of coal reserves, of which 54.4 billion metric tons are located in operating or developing mines. 3/ The total reportedly includes 102 billion metric tons of bituminous coal and 18 billion metric tons of lignite. Nearly all of these coal reserves are located in southwestern Poland in the upper and lower Silesian Basins. 4/ The upper basin is the main source of Polish coal reserves and contains 61 of the nation's 66 coal mines. Sources report that the operations of the mines in the upper basin are now highly mechanized and among the most modern in the world. 5/

Construction of coal-producing facilities at the Lublin coal basin in rural eastern Poland started in about 1975. Coal production did not begin at Lublin until late 1982, because the operation had been hampered by certain

---

1/ Peter James, op. cit., pp. 125-153.

2/ U.S. Department of State, Background Notes: China, December 1983, pp. 9-12; Peter James, op. cit., pp. 125-153; "China Encourages Foreign Investment," World Coal, June 1983, pp. 62-65; "Beijing Shakes the Dust Off Its Coal Reserves," Business Week, Mar. 7, 1983, pp. 86B and 86D; "Industrial Plans on Target," Petroleum Economist, January 1983, pp. 12-14; and, The Europa Yearbook 1982: A World Survey, vol. II, London, 1982, p. 110.

3/ Peter James, The Future of Coal, London, 1982, pp. 125-153; "After Prolonged Delay, Polish Coal Mine Starts Production," Coal Age, July 1983, p. 25; and, a speech entitled "Poland as a Producer and Exporter of Coal, by Stanislaw Zajac, Director of Economics, Weglokoks, Katowiced, Poland, before the Coal Outlook Conference on International Coal Trade, June 6 and 7, 1983, in Arlington, VA, sponsored by Pasha Publications.

The U.S. Department of Energy, Annual Prospects for World Coal Trade 1984: With Projections to 1984, July 1984, p. 5, reports that Poland's recoverable coal reserves amount to 39 billion metric tons, of which lignite represents 11.8 billion tons.

4/ Ibid.

5/ Ibid.

technical difficulties, a shortage of manpower, a lack of living quarters, and a reduction in construction funds. 1/

Operational lignite fields are located near the East German border, and newer lignite deposits have been discovered in central Poland. Lignite is used commercially in Poland in large mine-site powerplants.

Production

Poland is the fourth largest producer of coal in the world after China, the U.S.S.R., and the United States. In 1979, coal output in Poland reached an alltime high of 201 million metric tons. 2/ Because of labor problems, the output of coal in Poland declined in 1980 to 193 million metric tons, or by 4 percent from 1979, and still further in 1981 to 163 million metric tons, or by more than 15 percent compared with 1980. The Polish Government imposed martial law in December 1981, and designated coal as the number one priority. After the mines were militarized, the Polish Government succeeded in increasing coal production to 189 million metric tons in 1982, a 16 percent gain over 1981, and up to 191 million metric tons in 1983.

Importance to the Economy

Coal is extremely important to the Polish economy both internally as a major source of energy and externally as the leading individual item of trade. 3/ Coal accounts for more than 90 percent of the primary energy production in Poland. Coal supplies about 80 percent of Poland's industrial energy needs and furnishes about 95 percent of Poland's electricity (about 75 percent hard coal and about 20 percent lignite). Polish coal exports to the West are Poland's most important source of hard currency.

Consumption

Consumption of coal in Poland virtually equals production minus exports, since imports of coal are negligible compared with exports. During 1979-83,

---

1/ Peter James, op. cit., pp. 125-153; "After Prolonged Delay, Polish Coal Mine Starts Production," Coal Age, July 1983, p. 25; and, Stanislaw Zajac, op. cit.

2/ Stanislaw Zajac, op. cit.; "Polish Rebound," Coal Age, January 1984 p. 38; "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11; "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, Three Star Eastern Edition, Chicopee, Mass., Aug. 8, 1983, pp. 1 and 12; and, The Europa Yearbook 1982: A World Survey, vol. I, London, 1982, p. 994.

3/ Stanislaw Zajac, op. cit.; The Europa Yearbook 1982: A World Survey, Vol. I, London, 1982, p. 988 and 998; "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, Three Star Eastern Edition, Aug. 8, 1983, pp. 1 and 12; and, U.S. Department of State, Background Notes: Poland, June 1983. This source reports that in 1982 Poland had a debt of $26 billion and a debt service of $11.2 billion.

Poland's domestic consumption of coal ranged from a low of 148 million metric tons during 1981, a year of labor problems, to a high of 162 million metric tons in 1980. Domestic coal consumption amounted to 156 million metric tons in 1983. Domestic consumption of coal in Poland annually averaged about 84 percent of production during 1979-83 and ranged from 80 percent of production in 1979 to 91 percent in 1981. Poland reportedly exports its highest quality coal and uses lower grade material for its own energy needs. 1/

The utilities industry is the leading market for Polish coal and in the early 1980's accounted annually for about 45 percent of Poland's domestic coal consumption. Coal-fired generating capacity is projected to more than double, from 21,000 MWe in 1979 to 51,000 MWe in 1985. 2/ It is reported that most of this new generating capacity will be mine-mouth power stations.

Metallurgical and coking applications have annually accounted for about 16 percent of Poland's domestic coal consumption in recent years. The Polish Government has instituted a policy of limiting the growth of low-value, energy-intensive industries, which could slow the growth of coal in the coking industry.

In the late 1970's, direct industrial and domestic applications annually represented about 40 percent of domestic coal consumption, more than one-half of which was consumed in industrial boilers. 3/ Industry sources predict this use will decline to about only 10 percent of annual coal consumption in Poland over the 1980's as coal-derived substitutes, electricity and synthetic gas, replace coal in this market area. These substitutes reportedly could account for 40 percent of the annual consumption of coal in Poland by 2000. The first large-scale gasification plant is scheduled to start up at Libiaz, Silesia in the mid-1980's.

Industry Structure

Poland is a nonmarket economy country and all major industries are owned by the Government. The Ministry of Mining has overall responsibility for the Polish coal industry and sets the objectives for the industry. These objectives must be approved and ratified by the Polish Government. 4/ The State Mine Inspector(ate) is a separate organization, which reports directly to the Prime Minister. It has two major functions: (1) it makes certain that Polish mining laws are observed and (2) it supervises the development and use of the nation's coal deposits. Weglokoks is an independent organization that has responsibility for coal exports. 4/

Poland has 5-year plans to guide its economic growth. The plans for the Polish coal industry are prepared by the Ministry of Mining and Energy, and

---

1/ Stanislaw Zajac, op. cit.
2/ Peter James, op. cit., pp. 151; and, Stanislaw Zajac, op. cit.
3/ Peter James, op. cit., pp. 150 and 151.
4/ Peter James, op. cit., pp. 125-153; and, Stanislaw Zajac, op. cit.

are approved and ratified by the Government and Polish Parliament, respectively. The goals for the most recent 5-year plan covering 1981-85 have proven to be unattainable as a result of labor problems in the early 1980's. 1/

Coal technology available in Poland is considered by many Western observers to be first rate. This has occurred at least partly because coal is so vital to the Polish economy and is the primary source of hard foreign currency. 2/ Because of financial constraints, the latest technology is not always implemented within Poland. However, Poland does export the expertise, primarily through Kopex, the State-owned mining and engineering firm. Kopex has personnel working in six countries. Altogether, Poland has some 2,000 miners and mining specialists in 12 countries, with more than 1,000 of them working in Western and Third World nations that have coal reserves. 3/

Polish authorities encourage joint ventures with Western firms, as this permits foreign investment in new development. 4/ Poland's usual method of repaying these debts is through long-term coal agreements. The Western partner is guaranteed a share of any profit and may control up to 49 percent of a joint venture operating within Poland.

Trade

Poland's imports of coal are negligible in comparison to its exports of coal. Poland imported about 1 million metric tons of coal in 1980. 5/

Poland has been second only to the United States in terms of coal exports in recent years except in 1980 and 1981, the period of labor problems. In 1980, Poland dropped to third place in terms of world coal exports behind the United States and Australia and to fourth place in 1981 behind the above two nations plus South Africa. By 1982, under martial law, Poland once again became the world's second leading coal exporter.

1/ "The Next Three Years," Petroleum Economist, December 1982, pp. 512 and 513; The Europa Yearbook 1982: A World Survey, London, England, Vol. 1, 1982, p. 988; and, speech by Stanislaw Zajac, "Poland as a Producer and Exporter of Coal," June 6 and 7, 1983.

2/ Peter James, op. cit., pp. 125-153; Stanislaw Zajac, op. cit; and, "Poland Recaptures European Coal Markets," Coal Age, February 1984, pp. 11 and 13.

3/ Peter James, op. cit., pp. 125-153; Stanislaw Zajac, op. cit; and, "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11 and 13.

4/ John Paxton, The Statesman's Year-Book, 1982-83, New York, 1982, pp. 1,005; and, Peter James, op. cit., pp. 125-153.

5/ John Paxton, The Statesman's Year-Book, 1982-83, New York, 1982, pp. 1,005; and, Peter James, op. cit., pp. 125-153; Stanislaw Zajac, op. cit.; "Polish Rebound," Coal Age, January 1984, p. 38; "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11; "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, Three Star Eastern Edition, Chicopee, MA, Aug. 8, 1983, pp. 1 and 12; The Europa Yearbook 1982: A World Survey, vol. I, London, 1982, p. 988; and, U.S. Department of State, Background Notes: Poland, June 1983.

Poland's coal exports during 1978-83 are as follows (in millions of metric tons): 1/

Year	Quantity
1978	40.1
1979	41.1
1980	30.9
1981	15.0
1982	28.3
1983	35.0

Coal exports from Poland increased significantly in 1983, up more than 23 percent from 1982, 133 percent more than exports in 1981, but more than 15 percent below the record export level set in 1979.

For Poland, coal exports are a major source of foreign currency earnings. As stated previously, Poland needs Western hard currency to repay its international loans and to continue purchasing essential Western goods. 2/

During 1979-82, the EC, in the aggregate, was Poland's principal market for coal, accounting for a low of 4.4 million metric tons in 1981 to a high of 16.4 million metric tons in 1979 and amounting to 8.6 million metric tons in 1982. 3/ The EC's share of Poland's coal exports declined from more than 39 and 41 percent in 1979 and 1980, respectively, to more than 29 and 30 percent in 1981 and 1982, respectively. Major Western buyers of Polish coal in 1982 and 1983 included EC members Italy, France, and West Germany as well as non-EC member Finland. Each purchased more than 2 million metric tons of Polish coal in 1983.

The U.S.S.R has been the leading individual market for Polish coal as shown in the following tabulation: 4/

1/ Stanislaw Zajac, op. cit; Annual Prospects for World Trade 1984: With Projections to 1995, July 1984, p. 2; and, "Polish Rebound," Coal Age, January 1984, p. 38.

2/ John Paxton, The Statesman's Year-Book, 1982-83, New York, 1982, p. 1005; Peter James, op. cit., pp. 125-153; Stanislaw Zajac, op. cit.; "Polish Rebound," Coal Age, January 1984, p. 38; "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11; "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, Three Star Eastern Edition, Chicopee, MA, Aug. 8, 1983, pp. 1 and 12; The Europa Yearbook 1982: A World Survey, Vol. I, London, 1982, p. 988; and, U.S. Department of State, Background Notes: Poland, June 1983.

3/ Stanislaw Zajac, op. cit; "Poland Recaptures European Coal Markets," Coal Age, February 1984, p. 11; and, "Poland Counts on Coal to Cure Economic Ills, But Obstacles Remain," The Wall Street Journal, Eastern Edition, Aug. 8, 1983, pp. 1 and 12.

4/ Ibid.

Year	Quantity (million metric tons)	Share of total exports (percent)
1979-------------	9.4	22.7
1980-------------	6.0	19.4
1981-------------	3.7	24.7
1982-------------	8.7	30.7

Although the quantity of Polish coal exports to the U.S.S.R. declined sharply in 1981 from both 1979 and 1981, the U.S.S.R.'s share of these coal exports rose measurably in 1981 compared with the two preceding years. Other major Eastern European markets for Polish coal during 1979-82 were Czechoslovakia, East Germany, and Romania.

Poland's Western trading partners pay for coal purchases in their currency, which, in turn, can be used by Poland to buy needed Western goods and equipment. 1/ Poland's Eastern trading partners usually make payment in terms of goods, that is through bartering or countertrade. For example, Poland receives crude petroleum from the U.S.S.R. in exchange for Polish coal. 1/

Colombia

Reserves

Colombia represents more than 40 percent of Latin America's total coal reserves. 2/ Colombia has extensive coal deposits in mountain and valley zones. 3/ Coal deposits in the Central Highlands extend from near Cali, in the south to Medellin in the North. A second coal field extends from near Bogota northeastward to the Venezuela border.

A major coal deposit was discovered at El Cerrejon in the Guajira Department of Colombia, near the Venezuelan border, and a surface mine and necessary infrastructure (e.g., housing, port, and railroad) are near completion at this location. The mine at Cerrejon is officially scheduled to begin production in 1985, although shipments from Cerrejon reached 3 million metric tons in 1984. 4/ Operations at the mine are to be shared equally

---

1/ Ibid.

2/ Europa Publications Limited, The Europa Year Book 1984: A World Survey, vol. II, p. 1421; and, "Carbocol Secures Contracts," The Journal of Commerce, Feb. 25, 1985, pp. 1c and 7c.

3/ American University, Area Handbook for Colombia, 3rd ed., 1977, pp. 23, 24, 365, and 367.

4/ Wall Street Journal 3 Star, Eastern, Princeton, N.J., Jan. 11, 1985, p. 22; "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-53; Exxon Coal International-Intercor, The Cerrejon Project, Coral Gables, Fla., February 1984, pp. 11-27; "Carbocol Secures Contracts," Journal of Commerce, Feb. 25, 1985, pp. 1c and 7c; U.S. Department of Energy; Coal-Exporting Countries: The Asian Market, December 1984, pp. 27 and 28; and, Exxon, "Coal from Colombia," The Lamp, New York, vol. 66, No. 4, Winter 1984, pp. 2-11.

between the Colombian coal company Carbones de Colombia S.A. (Carbocol) and their U.S. partner. 1/ Trade sources report that it will not only be the largest coal mine in South America, but one of the largest in the world. 2/ Total coal reserves at Cerrejon 3/ are reported to be 16 billion to 40 billion metric tons of coal. 4/ Total recoverable reserves of coal at the Colombia-U.S. joint venture cite at Cerrejon are put in excess of 1.6 billion metric tons. 5/

Production

In the early 1970's, about 3 million metric tons of coal reportedly were produced annually in Colombia. 6/ By 1980, the annual level of coal production in Colombia had climbed to above 4.5 million metric tons and then climbed to nearly 6.4 million metric tons a year during 1982. 7/

The Cerrejon project is officially scheduled to begin with 2.7 million metric tons of coal output in 1986, when the essential ancillary infrastructure (i.e., the railroad) from the mine to the port and the export terminal complex (recently named "Puerto Bolivar" by the President of Colombia) which is located at Bahia Portete, is completed. However, an estimated 2.7 million metric tons of coal from Cerrejon will actually move from Bahia Portete in 1985. 8/

1/ Ibid.

2/ Ibid.

3/ Cerrejon is also known as "The Block," "The North Block," portion of the block is a 94,000 acre area which is the site of the Colombian-U.S. joint venture, the principal mine operation at Cerrejon. The north block is reported to contain 2.0 billion metric tons of coal to a depth of 650 feet and 3.0 billion tons of coal to a depth of 1000 feet. About 2.3 billion tons of coal are recoverable at 1000 feet.

4/ "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-53; and, "Carboco Secures Contracts," The Journal of Commerce, Feb. 25, 1985 pp. 1c and 7c. Another source reports that the Cerrejon deposit is estimated to contain from 16 to 40 billion metric tons of coal. This information was drawn from the Exxon Corp. The Lamp, New York, vol. 66, No. 4, Winter 1984, p. 4.

5/ Ibid.

6/ About one-fifth of this level of output or about 660,000 metric tons, reportedly was produced at Cerrejon alone in 1984. This was drawn from the Wall Street Journal 3 Star, Eastern, Princeton, N.J. Jan. 11, 1985, p. 22; American University, Area Handbook for Colombia, 3rd ed., 1977, p. 365; and, "Carbocol Secures Contracts," The Journal of Commerce, Feb. 25, 1984, pp. 1c and 7c.

7/ U.S. Department of State, Background Notes: Colombia, October 1981, p. 6; U.S. Department of Energy, Coal-Exporting Countries: The Asian Market, December 1984, p. 27; and, U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States: Colombia, FET. 83-080, October 1983, p. 4.

8/ The port will be fully operational early in 1986. Temporary barge and floating crane facilities will be used for shipping this early coal. This was drawn from Exxon Corp., The Lamp, Winter 1984, op. cit., p. 9; Exxon Coal International, The Cerrejon Project, February 1984, op. cit., pp. 11-25; U.S. Department of Energy, Coal-Exporting Countries: The Asian Market, December 1984, pp. 27 and 28.

Production at Cerrejon is slated to reach a level of 15 million metric tons per year by 1989, this is the current capacity of Puerto Bolivar and the total output at Cerrejon North Block is dedicated to exports. 1/

Importance to the Economy

Until the Cerrejon project, coal was of minimal importance to the economy of Colombia, since its total mining industry accounted for only about 1.1 percent of its GDP in 1981. 2/ Hydroelectricity is the most important energy source in Colombia and provided 70 percent of that country's energy needs in 1983, up from 17 percent in 1960. However, coal is expected to provide 19 percent of Colombia's energy requirements by 1990 and 24 percent by 2000. 3/ By 1990, coal exports from Cerrejon are expected to become Colombia's second-most important source of foreign currency after coffee. 4/ In addition, the development of the mine and infrastructure at Cerrejon has resulted in an influx of $360 million in foreign income, employment of about 100 Colombian subcontractors, and 11,000 persons engaged in various construction projects. 5/ By 1986, after all the base work is completed, about 3,000-4,000 permanent employees will operate the mine, railroad, and other ancillary facilities. 6/

Consumption

Colombia's consumption of coal has come almost entirely from domestic production since imports are nil. In the past, consumption of coal in Colombia virtually equalled production, since, until 1984, exports of coal were minimal.

Industry Structure

Until 1976, the coal industry in Colombia was controlled by 1300 small private companies joined in a federation called Fedecarbon. In 1976, the

---

1/ Exxon Corp., The Lamp, Winter 1984, op. cit., pp. 4-10. This source, p. 4 states that the amount of coal and rock removed from the mine in 1989 will be equivalent to digging another Panama Canal every 18 months; Exxon Coal International, The Cerrejon Project, February 1984, p. 5; and; "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54.

2/ The International Year Book and Statesmen's Who's Who 1983, London, England, 1983, p. 130.

3/ U.S. Department of State, Background Notes: Colombia, October 1981, p. 6; U.S. Department of of Commerce, Foreign Economic Trends and Their Implications for the United States: Colombia, FET 84-117, November 1984, p. 4. The International Year Book and Statesmen's Who's Who 1983, London, p. 130; The Europa Year Book 1984: A World Survey, vol. II, London, 1984, p. 1421.

4/ Ibid.

5/ Ibid.

6/ Exxon Corp., The Lamp, New York, vol. 66, No. 4, winter 1984, p. 4; and, Exxon Coal International, The Cerrejon Project, Corral Galbles, FL., February 1984, pp. 9, 11, and 13.

Government of Colombia created a state company, Colombian Coal (Carbacol), which was to help develop and modernize the coal industry. 1/ Carbacol received previously approved concession held by other Government agencies that had been negotiating with foreign companies. 2/ In order to accomplish this goal it was necessary to encourage foreign investment which had been opposed by Fedecarbon.

In December 1976, Carbocol and Intercor, an affiliate of a U.S.-based multinational firm, signed a contract, which is a 50-50 association agreement. 3/ Carbocol and Intercor manage the project jointly, they share equally in investment and operating costs, and each partner is entitled to half of the coal. Each party is responsible for producing and marketing its share of its coal. However, either party can, if it so desires, participate up to 50 percent in the other party's sales. Intercor is the project operator until 2009, when the association contract ends and the project reverts completely to Colombia. 4/ In addition, Intercor is to pay Carbocol a 15 percent royalty on its share of coal production.

In recent years, more than 90 percent of Colombia's coal mines have been small operations dedicated to the domestic market, and have employed out-of-date procedures. 5/ Since Colombia has not been a major coal producer, it has been necessary for the U.S.-based partner at Cerrejon to establish a workers' training program to supply, among other skills, trained equipment operators and maintenance men. 6/ Colombian college graduates are likewise being trained for professional positions. 7/

Foreign investment in its domestic coal mining industry is looked upon favorably by the Colombian Government as a means, through exports, of increasing and diversifying foreign exchange earnings. 8/ Besides hard-currency earnings, another important criterion of the Colombian Government in

---

1/ American University, Area Handbook for Colombia, 3rd ed., 1977, pp. 23, 24, 365, and 367.

2/ Ibid.

3/ "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54; Exxon Coal International, The Cerrejon Project, Coral Gables, Fla., February 1984, pp. 11-23; and, Exxon Corp., The Lamp, New York, vol. 66, No. 4, Winter 1984, pp. 2-10.

4/ Ibid.

5/ Nachrichten fur Aussenhandel (i.e., Packaging Information), Cologne, West Germany, Aug. 29, 1984, p. 5; "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54; Exxon Corp., The Lamp, New York, vol. 66, No. 4, Winter 1984, pp. 2-10; and U.S. Deparment of Energy, Coal Exporting Countries: The Asian Market, December 1984, pp. 27 and 28.

6/ Ibid.

7/ Ibid.

8/ "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54; U.S. Deparment of Energy, Coal Exporting Countries: The Asian Market, December 1984, pp. 27 and 28; U.S. Department of State, Background Notes: Colombia, October 1981, pp. 6 and 7; The Europa Year Book 1984: A World Survey, Vol. II, London, 1984, p. 1421; Exxon Corp., The Lamp, New York, vol. 66, No. 4, Winter 1984, p. 4; and, U.S. Department of Commerce, Foreign Economic Trends and Their Implications for the United States: Colombia, FET. 84-117, November 1984, pp. 8 and 10.

measuring the desirability of foreign investment is whether or not it is labor intensive and will employ mostly native Colombians. 1/ The coal industry is labor intensive and will create new employment at both the production and management levels.

To enjoy the tariff benefits of the Andean Common Market, a firm must be at least 51 percent Colombian owned. However, based on the reported association arrangement between Carbocol and Intercor, Colombia apparently is flexible in its application of the Andean Pact's foreign investment regulations.

Trade

Colombia's imports of coal reportedly are negligible in comparison to both its production of coal and its current (1985) and potential exports of coal. Until 1985, exports of coal by Colombia were small. As stated previously, 2.7 million metric tons of coal from the Cerrejon mine are to be exported during 1985 via the new port facilities, Puerto Bolivar, at Bahid Portete. 2/ As was stated earlier, the entire output of the Carbocol-Intercor operation at Cerrejon's North Block is dedicated to exports and is scheduled to reach 15 million metric tons per year by 1989. Western Europe is the primary target for these exports. The United States and Israel also are current markets for Cerrejon's coal exports. The Intercor-Carbocol associations is also looking at the Caribbean, South America, and the Far East as potential markets. 3/

Colombia also plans to produce and export coal from the Central and South Blocks of the Cerrejon field. The Central Block reportedly is operated by the Colombian Government alone. 4/ Nothing has been found in the literature regarding Colombia's plans for the South Block at Cerrejon, except that Colombia eventually plans to produce coal at the South Block. 5/

Colombia plans to export 27 million metric tons of coal a year by 1990 and these exports are projected to climb to 54 million metric tons annually by

---

1/ Ibid.

2/ Exxon Corp., The Lamp, New York, vol. 66, No. 4, Winter 1984, pp. 3-10; Exxon Coal International, The Cerrejon Project, Coral Gables, FL, February 1984, pp. 5, 11, 13, and 17-23; U.S. Department of Energy, Coal-Exporting Countries: The Asian Market, December 1984, pp. 27 and 28; "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54; "Carbocol Secures Contracts," Journal of Commerce, Feb. 25, 1985, pp. 1c and 7c; and, "New Delhi Conference: U.S. Will Remain Top Coal Nation," Coal Age, February 1985, p. 19.

3/ Ibid.

4/ "Colombian Exports, Coal Age, August 1984, p. 39. Another source reports that the Central Block at Cerrejon is a joint operation between Colombia and Spain. This was drawn from "Carbocol Secures Contracts," The Journal of Commerce, Feb. 25, 1985, pp. 1c and 7c.

5/ U.S. Department of Energy, Coal-Exporting Countries: The Asian Market, December 1984, pp. 27 and 28.

2000. 1/ The U.S. based partner in the Intercor-Carbocol association at Cerrejon's North Block plans to spend upwards of a total of $3 billion or more and has spent $500 million on this project through 1984. 2/ Under the National Development Plan (1983-86) the Colombian Government plans to invest $21.4 billion in 100 projects including mining, electrical energy, transport, and industry. Reportedly, the Colombian Government plans to spend a total of $5 billion developing its coal mines in order to reach 54 million tons of coal exports per year by 2000. 3/

FUTURE PROSPECTS FOR WORLD COAL DEMAND

Since 1978, extensive reports have projected future world demand for coal. Most of these studies predict continued coal demand growth through 1990 and beyond. However, the decline in overall energy consumption, fluctuating crude petroleum prices, and economic difficulties worldwide have caused delays in crude petroleum-to-coal conversions and recently slowed demand for steam coal. Although coal demand is likely to increase, the growth in demand is expected to be slower than projected. 4/

Table 20 shows various projections for steam coal imports. These projections, which were reported prior to the 1983 drop in crude petroleum prices, are still considered valid as to their long-term projections; however, the specific volumes projected are high in light of a lessened demand for electricity.

These estimates were based on economic growth rates that have been much lower than anticipated. For example, in 1980, the EC's projected coal demand assumed growth of 3.5 percent per year; however, actual growth between 1980 and 1983 was lower and estimated to be 2.5 percent per year from 1983 to 2000.

The Pacific Rim nations are also experiencing declining growth in energy demand. Japan's economic growth of 10 percent during 1963-73 declined to 4 percent by 1980, and the latest Government energy plan predicts future economic growth between 3 to 5.5 percent through 2000.

Electricity Generation

Future coal use in electricity generation depends primarily on the growth of electricity demand, which now is uncertain. Future electricity demand may

---

1/ "New Delhi Conference: U.S. Will Remain Top Coal Nation," Coal Age, February 1985, p. 19; and, The Europa Year Book 1984: A World Survey, vol. II, London, 1984, p. 1421.

2/ Exxon Coal International, The Cerrejon North Block Project, Coral Gables, FL, Apr. 2, 1985; "Cerrejon Puts Colombia in Spotlight," Coal Age, November 1983, pp. 50-54; and, The Europa Year Book 1984: A World Survey, vol. II, London, 1984, p. 1421.

3/ The Europa Year Book 1984: A World Survey, vol. II, London, England, 1984, p. 1421; and, Les Echos, Paris, France, Mar. 22, 1982. p. 4.

4/ U.S. General Accounting Office, Prospects for Long-Term U.S. Steam Coal Exports to European and Pacific Rim Markets, Aug. 4, 1983, p. 8.

Table 20 --Steam coal import projections, 1985-2000

(Millions of short tons)

Region	IEA 1/	WOCOL 2/	ICE 3/	ICF 4/	WESTPO 5/	IEA 6/	EIA 7/	NCA 8/
EC								
1985	120	9/	77-99	79	9/	9/	89	9/
1990	106	73-137	113-154	142	9/	9/	139	9/
1995	9/	9/	9/	215	9/	9/	179	9/
2000	249	101-265	189-254	9/	9/	9/	216	9/
Total Europe:								
1985	130	9/	97-123	103	9/	9/	114	108
1990	119	92-160	146-190	179	9/	135	172	165
1995	9/	9/	9/	262	9/	9/	235	9/
2000	277	142-422	268-343	9/	9/	9/	294	9/
Pacific Rim:								
1985	9/	32	43	58	72-78	9/	52	50
1990	9/	79	90	117	130-148	9/	109	105
1995	9/	9/	9/	200	9/	9/	169	9/
2000	9/	229-263	202-222	9/	9/	9/	235	9/
Total World:								
1985	9/	119-170	140-166	161	9/	9/	191	178
1990	9/	9/	236-280	295	9/	9/	315	300
1995	9/	9/	9/	462	9/	9/	440	9/
2000	9/	340-771	470-565	9/	9/	9/	572	9/

1/ International Energy Agency, Steam Coal: Prospects to 2000, 1978.

2/ World Coal Study (WOCOL), Future Coal Prospects: Country and Regional Assessments, 1980.

3/ Department of Energy, Draft Interim Report of the Interagency Coal Export Task Force, January 1981.

4/ ICF, Inc., Potential Role of Appalachian Producers in the Steam Coal Export Market: Task #1, International Steam Coal Trade Analysis, November 1981.

5/ Western Governors' Policy Office (WESTPO), Western Coal Exports, December 1981.

6/ International Energy Agency, Coal Prospects and Policies in IEA Countries, 1981 Review, 1982.

7/ U.S. Department of Energy, Energy Information Administration (EIA), U.S. Coal Exports: Projections and Documentation, March 1982.

8/ National Coal Association (NCA), Looking Ahead to 1995: A Forecast for U.S. Coal, April 1982.

9/ Not covered by report.

Source: U.S. General Accounting Office, Prospects for Long-Term U.S. Steam Coal Exports to European and Pacific Rim Markets, Aug. 4, 1983.

grow, but how soon and how much largely depend on the rate of economic recovery and the effect of energy conservation practices throughout the world. 1/ Coal and nuclear power still have cost advantages over crude petroleum and power. France's strategy, for example, is to provide its base-load requirements from the most economical source--nuclear plants--and to provide peaking power largely from coal-fired plants. Based on nuclear projects already under construction, Belgium anticipates that the use of nuclear energy in electricity generation could increase from 16 percent in 1980 to almost 40 percent by 1990. Many other countries, however, have deferred nuclear programs for various reasons and plan to expand their use of coal for generating electricty. 2/

The International Energy Agency (IEA) projected that coal use for electricity generation could increase substantially by 1990 in Western Europe and the Pacific Rim nations. It also cautioned that more than one-half of the planned additions to capacity were not yet under construction and that delays would undoubtedly occur. The IEA reported that conversion of existing crude petroleum-fired powerplants to coal was pursued to varying degrees by member nations. For example, West Germany does not consider such conversion to be economical because many of its single-fuel, crude petroleum-fired plants are new. West Germany has, however, switched some multifuel plants to coal and generally restricts operation of the crude petroleum-fired plants to peak load periods. Italy and Japan are in the process of converting to coal and Denmark has completed its conversion to coal. In other countries, however, conversion has either not yet started or is still in the planning stage. 3/

General Industry

The general industry sector has the potential to be the fastest growing steam coal market in the future. The IEA's Coal Industry Advisory Board reported that a steam coal market in OECD countries 4/ of up to 500 million metric tons per year by 1990 and 700 million metric tons per year by 2000 could be technically and economically feasible. However, constraints, such as the capital required to convert existing boilers to coal, need to be addressed.

Residential

The residential/commercial building sector, composed of many small consumers, is unlikely to hold much potential for further coal use, with two exceptions. Coal-fired district heating systems represent one method of

---

1/ Ibid., p. 9.

2/ Ibid.

3/ Ibid.

4/ Member countries of the OECD are Australia, Austria, Belgium, Canada, Denmark, Finland, France, West Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

efficient coal use in this sector. Denmark, which projects that over 33 percent of its 1985 heating demand will be met through district heating systems, and Sweden, which projects 50 percent by 1990, are among the few countries with significant potential in this area. West Germany and France also have projects underway, and Ireland and the United Kingdom are looking at combined heat and powerplants. The second method for coal use in this sector is the use of electricity from coal-fired powerplants for electric heat pumps as an end-use energy source.

Development of Coal Technology

Many current objections to using coal center around the view that it is dirty, difficult, inconvenient to handle and store, and environmentally unacceptable. New technologies are aimed at overcoming these problems as well as improving the economics of coal versus crude petroleum and natural gas.

Coal cleaning

Coal is cleaned to remove dirt, ash, and sulfur, improving the heating value and reduce emissions. Washing coal removes dirt and some pyritic sulfur, and chemical cleaning removes virtually all pyritic sulfur and up to 50 percent of organic sulfur; however, chemical cleaning may not remove ash and mining waste and may need to be combined with washing. Therefore, organic cleaning techniques using microorganisms are also under study.

Coal-liquid mixtures

Composite fuel mixtures, such as coal and crude petroleum or coal and water, are currently in commercial use and may have a more immediate impact on increasing coal demand than some of the other technologies under development, since they allow many crude petroleum-burning facilities to burn coal without changing basic equipment. Both mixtures are now being commercially produced in the United States. Several U.S. utilities burn coal-crude petroleum mixtures, and others are testing coal-water mixtures. These fuels can be transported through pipelines and by tankers and thus offer an economic advantage to crude petroleum to both electric utilities and general industry.

Fluidized bed combustion

Fluidized-bed combustion (burning pulverized coal at low temperatures in beds of sand and/or limestone through which fine jets of air are passed) offers an improved method of coal combustion in both the industrial steam heating and the power generation markets. The advantages are the ability of a fluidized-bed combustor to burn any type or quality of coal while significantly reducing sulfur emissions without costly flue gas treatment. Also, the lower combustion temperature reduces nitrogen oxide emissions and ash formation.

Other technologies that could increase coal use in the more distant future include: (1) coal liquefaction and gasifaction for use in place of natural gas and petroleum products, (2) fly ash processing to recover and use waste byproducts of coal combustion, and (3) fuel cells using coal-derived fuels.

Competing Energy Sources and Environmental Concerns

Alternative energy sources, such as solar energy, offer the advantage of indigenous production as well as little or no requirement for pollution controls. If some of these technologies are developed to the point where they become economically attractive, they could offer strong competition for coal. By the year 2000, new equipment using renewable energy sources that have been demonstrated to be reliable and commercially available at attractive prices and offer the prospect of low operating costs with no pollution could be available.

Concerns about the environmental effects of using coal and the costs of complying with environmental standards could lead to doubt about switching to coal.

Environmental control measures increase the cost of coal use, thus eroding its comparative Btu cost advantage over crude petroleum. Many countries apply stricter standards to new combustion equipment than to existing equipment. Since most coal-fired equipment would be among the new types of equipment it would be subject to the stricter standards.

Coal's primary environmental impact results from the combustion process. Emissions in areas of high combustion as well as other regions as a result of long-distance transport of pollutants (the formation of acid rain), is an issue receiving increasing attention in West Germany and Northern Europe, and could affect future European steam coal use.

POSSIBLE IMPLICATIONS OF CHANGING WORLD CRUDE PETROLEUM PRICES ON U.S. COAL TRADE

The following section presents data derived from the use of econometric modeling to determine possible future changes in U.S. coal trade as a result of changing world crude petroleum prices. As previously shown in this report, there is a direct correlation between the price of crude petroleum and the price of coal as well as coal's viability as an energy source.

There are many factors that could affect future U.S. coal trade. For the purposes of this study, a forecast of future U.S. coal trade balances is based on the price of crude petroleum. Three independent crude petroleum price scenarios, developed by the Commission for a previous study, 1/ were used as input to the Coal Service of Data Resources, Inc. (DRI) in order to measure the effects of these crude petroleum price scenarios on the U.S. coal trade

---

1/ U.S. International Trade Commission, Possible Effects of Changing World Crude Petroleum Prices, USITC Publication 1494, February 1984, p. 141.

balance in 1990 and 1995. 1/ The following tabulation shows the three crude petroleum price scenarios for 1990 and 1995 (in 1983 dollars per barrel): 2/

Year	Low-crude petroleum price scenario	High-crude petroleum price scenario	Crude petroleum price shock scenario
1990	26	41	90
1995	37	70	75

In order to develop the correlation between crude petroleum prices and coal prices, the scenarios were converted to 1983 dollars per million Btu's as shown in figure 4.

These petroleum price scenarios do not take into account any changes in Government policy that could affect the price of domestic or foreign crude petroleum. The projected future prices are based on past events. The prices in the low- and high-price scenario do not reflect any price shocks but instead take into account only supply pressures generated in the market place by such factors as changes in demand, the growth of alternative fuels, and general worldwide economic pressure. The price-shock scenario reflects a major disruption in the supply of crude petroleum that results in a rapid increase in price during a short period of time.

Net Trade

Scenarios

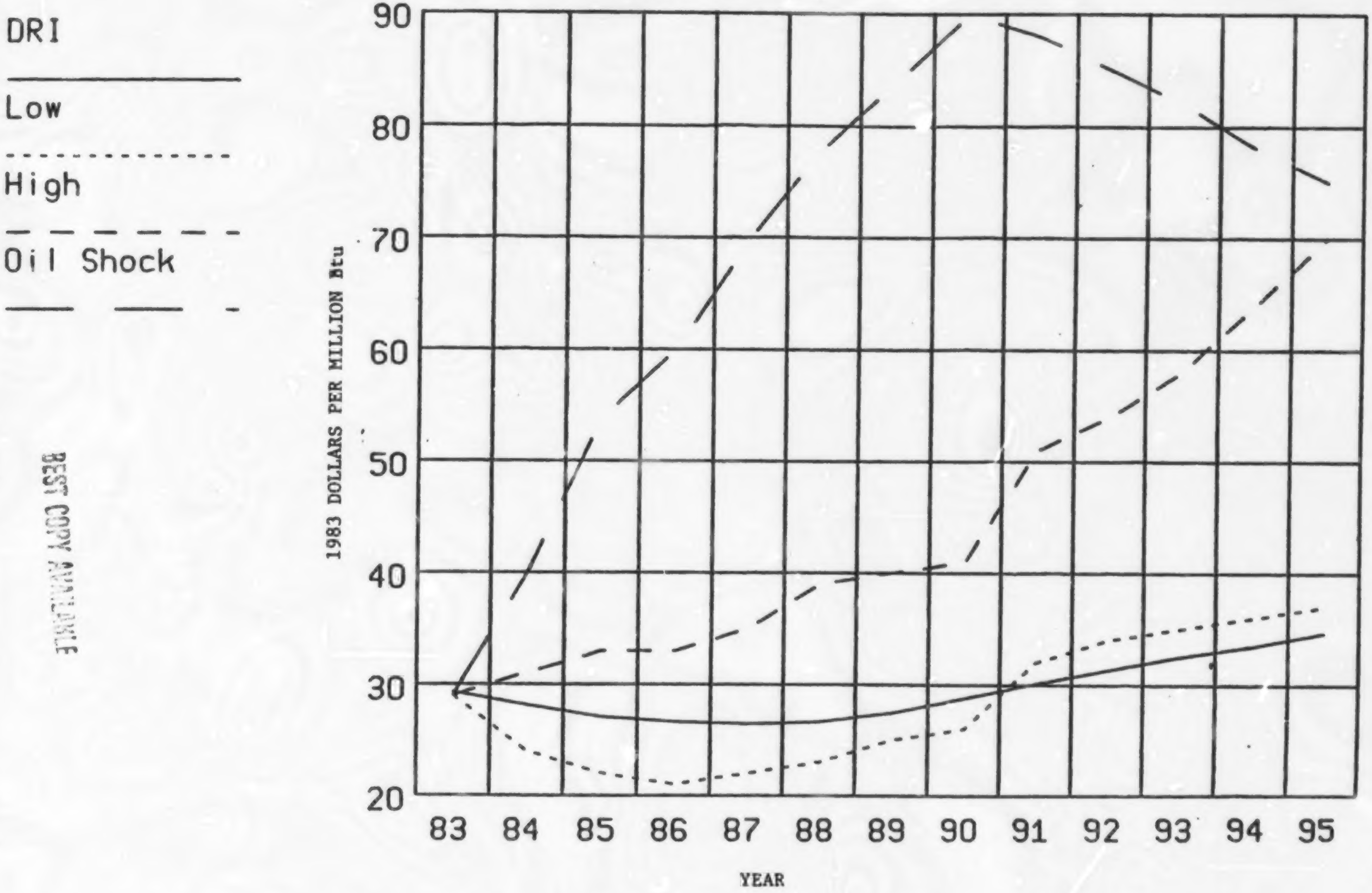
The trade balances for coal show little change from the low to high-shock scenarios in both 1990 and 1995 (table 21). Under each scenario, the United States continues to maintain a positive trade balance in terms of coal; however, the positive trade balance improves more under the low price scenario. 3/

1/ The model's raw data output was presented to the Commission staff for analysis.

2/ It should be noted that the value of an econometric model is to provide a benchmark for policymakers. Model results are good predicators of possible future effects only if the relationships that have existed in the past hold true in the future. Model results should be interpreted as indicating the direction and magnitude but not the precise size of price changes.

3/ The trade balances are expressed in nominal dollars in order to compare data without consideration of the effects of inflation during the period.

Figure 4.--Comparative crude petroluem price scenarios



Source: Data Resources, Inc., Coal Service, "U.S. Coal Trade Balance," Prepared for the U.S. International Trade Commission, Aug. 24, 1984.

Table 21.--U.S. coal trade balance, under the low-, high-, and shock price scenarios, 1990 and 1995

(In millions of nominal dollars)

Year	Low-price	High-price	Price-shock
1990	5,382.0	5,110.0	4,834.8
1995	7,912.9	7,632.2	7,475.5

Low-price scenario

Net trade is the highest under the low crude petroleum price scenario. Although the crude petroleum is rising, it is a gradual increase, reaching only $37 per barrel. Therefore, the United States could continue to rely on crude petroleum for energy needs and export coal production in order to satisfy world demand for coal.

As a result of the low-priced crude petroleum, world demand for coal would most likely decrease. However, under the scenario, if crude petroleum prices are $26 per barrel in 1990, world demand for coal would increase, assuming that the low crude petroleum price resulted in decreased exploration and supply, and the positive U.S. trade balance could increase to $5.4 billion. The U.S. trade balance could reach $7.9 billion in 1995 if crude petroleum is priced at $37 per barrel. At this price, world demand for coal could rise significantly, and the United States, seen as a secure source of supply by the world's coal importing nations, could capture a large share of the world market.

High-price scenario

Under the high-price scenario, the price of crude petroleum steadily increases to $70 per barrel in 1995. If crude petroleum prices rise, coal would become a more attractive source of energy, and the U.S. trade balance in coal could increase to $5.1 billion in 1990 and $7.6 billion in 1995.

Price-shock scenario

Under the price-shock scenario, with a substantial increase in crude petroleum prices in the short term, it is likely that the United States would turn to coal to replace crude petroleum as a fuel and chemical feedstock. If, by 1990, crude petroleum prices reach $90 per barrel, world demand for coal would rise significantly, and the U.S. trade balance could increase to $4.8 billion in 1990 and $7.5 billion in 1995. Since coal would become a more viable energy source under this scenario, more coal would be consumed domestically; therefore, the U.S. coal trade balances, although increasing in 1990 and 1995, are lowest compared with the other price scenarios.

Comparison of Three Scenarios and DRI's Base Case

Figure 5 gives the DRI base case forecast for steam and metallurgical coal exports. The base case forecasts of coal trade are shown in the following tabulation (in millions of short tons):

Trade	1990	1995
Coal exports:		
Metallurgical	51.584	55.750
Steam	24.012	29.683
Total	75.596	85.433
Coal imports:		
Metallurgical	3.150	4.900
Steam	1.200	1.560
Total	4.350	6.460

Under the three scenarios, metallurgical coal exports increase only under the low-price scenario to about 55 million short tons in 1995 (figure 6); DRI's base case shows metallurgical exports reaching 55.7 million short tons by 1995. Metallurgical coal exports may increase under this scenario if technological advances result in the shift back to coal and away from electric furnaces. Also, under the low-price scenario, the model projects improved economic conditions which could result in an upswing in steel production.

U.S. steam coal exports could increase significantly under all three price scenarios as well as under DRI's base case (figure 7). U.S. steam coal exports in 1995 could reach about 29 million short tons under the low-price scenario; 28 million short tons under the high-price scenario; and 27.5 million short tons under the price-shock scenario. DRI's base case shows U.S. steam coal exports at 29.7 million short tons by 1995.

Input/Output Model

The U.S. Department of Labor input/output model can be used to calculate the change in U.S. industry output and employment resulting from any given hypothetical change in final demand for a domestically produced commodity. The model is based on the input/output relations existing in the U.S. economy in 1977 and 1981 productivity factors (employment-output ratios). 1/

1/ It should be noted that to the extent that the input/output relationships have changed since 1977, the model results will not reflect the current situation. Also, the price scenarios presented previously relate to the 1990-95 period and the actual input/output relations and labor productivity in 1990 and 1995 will most likely differ from those in the model.

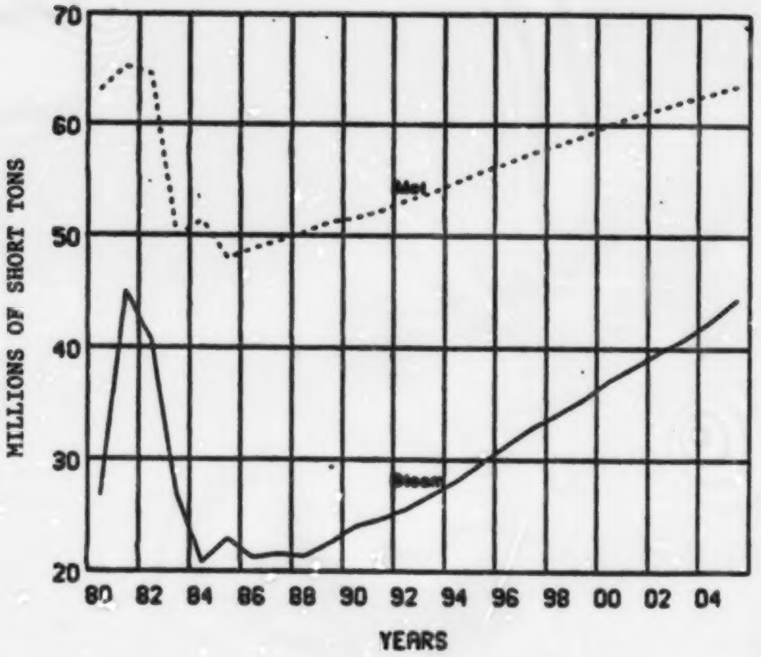
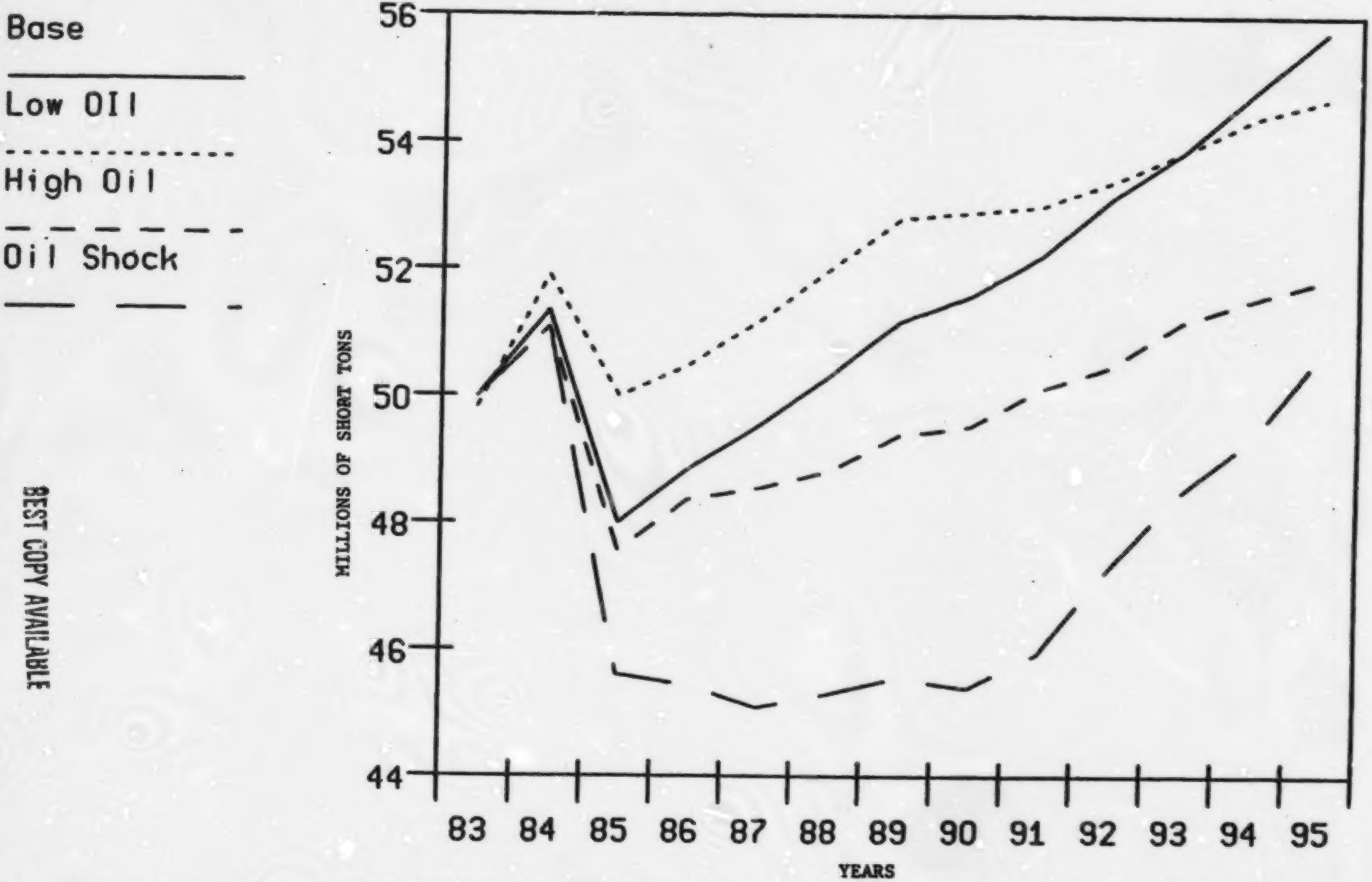


Figure 5.--DRI base case forecast of metallurgical and steam coal exports

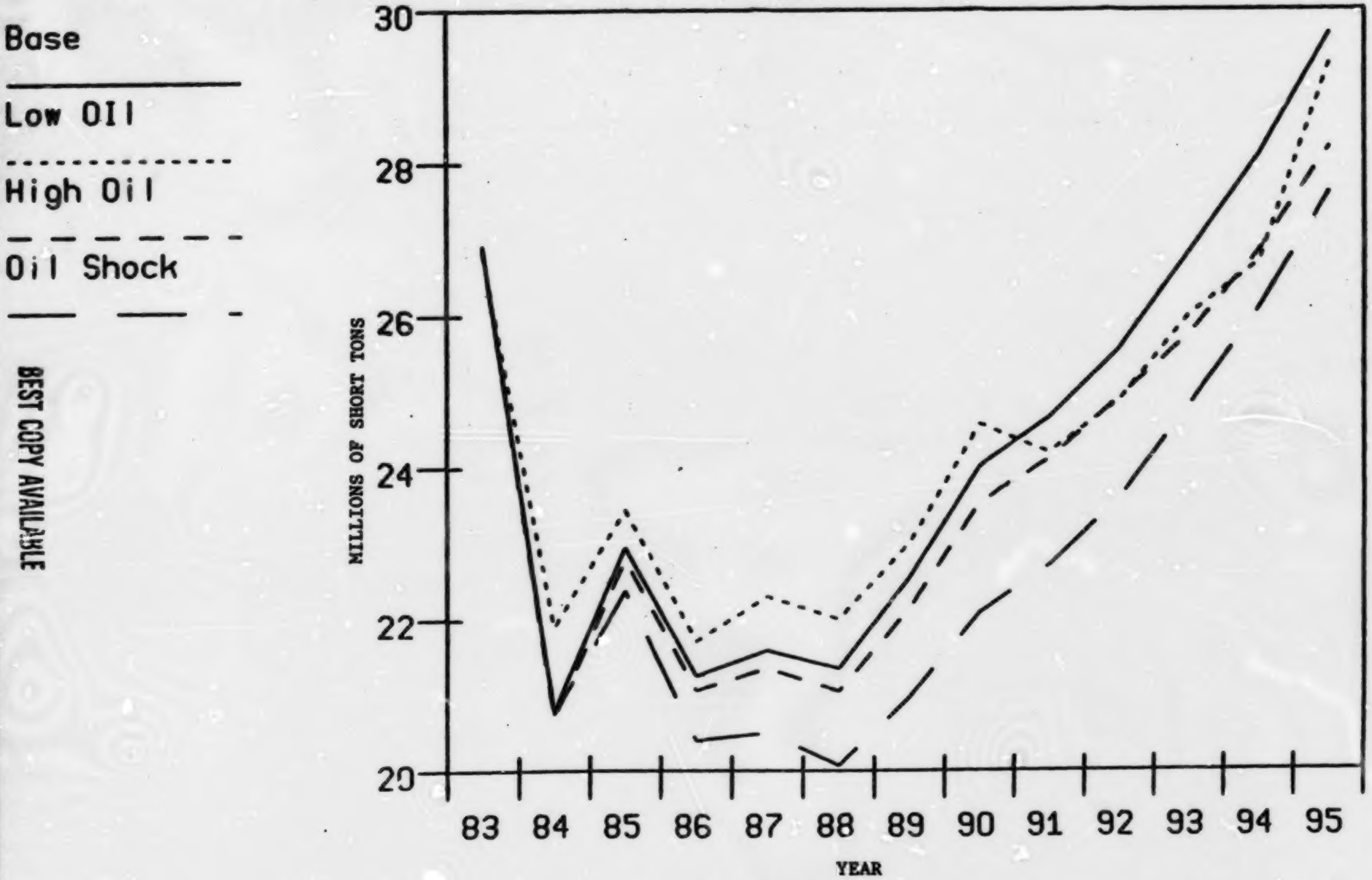
Source: Data Resources, Inc., Coal Service, "U.S. Coal Trade Balance," Prepared for the U.S. International Trade Commission, Aug. 24, 1984.

Figure 6.--Forecast of U.S. metallurgical coal exports under the three scenarios.



Source: Data Resources, Inc., Coal Service, "U.S. Trade Balance," Prepared for the U.S. International Trade Commission, Aug. 24, 1984.

Figure 7.--Forecast of U.S. steam coal exports under the three scenarios



Source: Data Resources, Inc., Coal Service, "U.S. Trade Balance," Prepared of the U.S. International Trade Commission, Aug. 24, 1984.

104

The estimates of the effect on production of net trade can vary with different assumptions about the elasticities of demand and supply. For this study, a one-to-one ratio is assumed between net trade changes and production changes. This assumption implies an infinite supply elasticity or a zero demand elasticity or that any increase in imports replaces domestic production; domestic prices, consumption, exchange rates, and other variables are assumed to be unaffected by changes in imports and exports.

Changes in industry output and employment provided by the input/output model are upper limits. An increase in demand will be reflected by the model as an increase in output and employment.

Changes in Industry Output

These net trade increases were used as input into the BLS model. The model indicates that the output of the entire U.S. economy could increase from $1.7 billion to $2.9 billion in 1990. The coal mining sector could see increases in output of $888 million to $1.5 billion in 1990; the mining equipment sector's output could increase from $59 million to $101 million. Output for the railroad industry could increase from $10 million to $17 million; $16 million to $27 million for trucks; electric utilities could show output increases of $31 million to $53 million.

In 1995, the entire U.S. economy could show output increases of $7.4 billion to $8.3 billion. The coal mining sector could increase output from $3.9 billion to $4.4 billion in 1995; $260 million to $293 million for the mining equipment sector; and $137 million to $154 million for electric utilities. The transportation industry could show 1995 output increases of $44 million to $50 million for railroads and $68 million to $77 million for trucking.

Table 22 shows the increases in output possible in selected sectors of the U.S. economy.

Changes in Industry Employment

In 1990, the coal-mining sector could experience employment gains ranging from 26,145 to 44,406 jobs; 1,598 to 2,715 jobs could be gained in the mining equipment sector. The railroad industry could gain between 313 and 532 jobs, and the trucking industry could gain from 666 to 1,131 jobs. Electric utilities could have job increases ranging from 462 to 785 in 1990, and the entire U.S. economy could gain from 49,047 to 83,302 jobs.

In 1995, the coal mining industry could gain from 114,266 to 128,862 jobs; the mining equipment industry could experience gains ranging from 6,985 to 7,878 jobs. In the transportation sector, railroads could witness job gains of 1,370 to 1,545, and 2,911 to 3,282 trucking jobs could be gained. In 1995, the number of jobs gained by electric utilities could range from 2,020 to 2,278. The entire U.S. economy could experience job increases in 1995 ranging from 214,355 to 241,736.

Table 23 shows the number of jobs that could be gain for certain sectors of the U.S. economy.

Table 22.--Possible increases in output as a result of net trade increases between 1983 and the scenarios in 1990 and 1995, by specified sectors

(In millions of nominal dollars)

Sector	Low-price		High-price		Price-shock	
	1990	1995	1990	1995	1990	1995
Coal mining----	1,509.01	4,379.05	1,200.57	4,060.74	888.49	3,883.04
Crude petroleum/natural gas----------	26.61	77.23	21.17	71.62	15.67	68.48
Mining equipment---------	101.13	293.48	80.46	272.15	59.55	260.24
Transportation:						
Railroads----	17.30	50.20	13.76	46.55	10.19	44.51
Trucks-------	26.61	77.23	21.17	71.62	15.67	68.48
Water--------	3.99	11.58	3.18	10.74	2.35	10.27
Services-----	1.20	3.48	.95	3.22	.71	3.08
Electric utilities----	53.23	154.46	42.35	143.24	31.34	136.97
Total economy--	2,868.99	8,325.61	2,282.56	7,720.42	1,689.23	7,382.58

Table 23.--Possible gains in the number of jobs as a result of the net trade increases between 1983 and the scenarios in 1990 and 1995, by specified sectors

(Number of jobs)

Sector	Low-price		High-price		Price-shock	
	1990	1995	1990	1995	1990	1995
Coal mining	44,406	128,862	35,329	119,495	26,145	114,266
Crude petroleum/ natural gas	426	1,236	339	1,146	251	1,096
Mining equipment	2,715	7,878	2,160	7,305	1,598	6,985
Transportation:						
Railroads	532	1,545	424	1,432	313	1,370
Trucks	1,131	3,282	900	3,044	666	2,911
Water	107	309	85	287	63	274
Services	120	348	95	322	71	308
Electric utilities	785	2,278	625	2,113	462	2,020
Total economy	83,302	241,736	66,275	224,164	49,047	214,355